TITLE PAGE

THE DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF AN INTEGRATED FRAMEWORK FOR UNDERGRADUATE PHARMACY EDUCATION IN MATERNAL AND CHILD HEALTH AT THE UNIVERSITY OF THE WESTERN CAPE

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor Philosophiae in the School of Pharmacy, University of the Western Cape.

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"Before she went into labour, she had the baby. Before the birth pangs hit, she delivered a son.

Do I open the womb and not deliver the baby? Do I, the One who delivers babies, shut the womb?

Isaiah 66: 7 & 9 (KJV)

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Elizabeth Oyebola Egieyeh

KEYWORDS

Maternal and child health

Pharmacy undergraduates

Integrated curriculum

Traditional curriculum

Knowledge and skills

Reproductive and sexual health

Neonatal and child care

Maternal and antenatal care

Infant growth assessment skills

Service-learning in Pharmacy

ABSTRACT

THE DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF AN INTEGRATED FRAMEWORK FOR UNDERGRADUATE PHARMACY EDUCATION IN MATERNAL AND CHILD HEALTH AT THE UNIVERSITY OF THE WESTERN CAPE

Elizabeth Oyebola Egieyeh

PhD thesis, School of Pharmacy, University of the Western Cape.

Background

The high rate of maternal and child mortality is a global health concern. Nationally, it is one of South Africa's quadruple disease burdens. The Sustainable Development Goal 3, 2030 targets related to maternal and child health (MCH) were implemented to reduce the rate of mortality. The interventions that led to reducing mortality rates during the Millennium Development Goals era, such as improved access to quality healthcare services and skilled healthcare workers, need to be scaled up and accelerated to achieve the SDG 3 targets. As easily accessible frontline healthcare workers, pharmacists play an essential role in the continuum of care for MCH as guided by international and local regulatory health bodies. However, studies have shown that pharmacists feel ill-prepared and uncomfortable rendering MCH services, attributed to most pharmacy schools' curriculum content and teaching methods. Proponents of global reforms in health professional education propose that the traditional method of teaching along disciplines that leads to compartmentalised and fragmented learning should be replaced with an integrated one that incorporates service learning. The purpose of the proposed change in teaching method is to produce graduates that are fit to meet the local needs of the community they serve through enhanced student learning, knowledge retention, critical thinking and problem-solving skills. In addition, active learning strategies should be infused in teaching and learning to engender student participation and knowledge retention. The study reported in this thesis was divided into three phases from 2017 to 2019. The first phase aimed to evaluate the knowledge and skills of 2017 fourth-year undergraduate pharmacy students exposed to a traditional MCH curriculum at the School of Pharmacy, University of Western Cape, in a baseline study. In phase two, an intervention to integrate the MCH framework for undergraduate training was developed and implemented in a longitudinal study involving the 2017 second-year students through to their fourth year of study in 2019. Lastly, a comparative

evaluation of students' knowledge and skills in the traditional and integrated curricula was carried out in the third phase. At the time of writing this thesis, the study is the only one to evaluate and review undergraduate pharmacy curriculum content in maternal and child health in South Africa.

Method

The study was a descriptive, quantitative, longitudinal and non-randomised program evaluation research that spanned from 2017 to 2019 and employed an iterative action cycle in a four-year Bachelor of Pharmacy programme for generalist pharmacists. Convenience samples of four cohorts of undergraduate students participated in the study. The first cohort was made up of 2017 second-year (n = 47) undergraduate pharmacy students. The second, third and fourth cohorts were 2017 (n = 54), 2018 (n = 41) and 2019 (n = 47) fourth-year undergraduate pharmacy students. Data were collected with two 34-item, paper-based, self-administered questionnaires developed for the second and fourth-year cohorts. Sections of the questionnaires assessed participants' knowledge of (1) reproductive and sexual health, focused mainly on contraception which was longitudinally dispersed in the second and fourth years of study, (2) maternal and antenatal care, (3) neonatal and child care, and (4) infant growth assessment skills. The Statistical Package for Social Sciences (SPSS) version 26 was used for analysis. A score of 50% in each section of the questionnaire indicated a pass. One-sample t-test was used to compare participants' mean scores to the university pass mark of 50% to determine the pass rate. One-way repeated-measures analysis of variance (ANOVA) with post hoc test was used to determine the difference in participants' mean scores in the second phase of the study (pre, post and two years post-intervention assessments). In the third phase of the study, one-way between-groups ANOVA with post hoc test was used to compare the mean scores of fourth-year students exposed to the traditional curriculum (2017 and 2018 cohorts) and the 2019 cohort exposed to an integrated curriculum. Stepwise linear regression analysis was used to predict the effect of participants' demographics on knowledge and skills acquisition and retention. Cronbach's alpha was calculated to quantify the test reliability.

Results

In phase one, a 61% participation rate was recorded in the baseline knowledge and skills evaluation survey of 2017 fourth-year students exposed to a traditional curriculum. More than half of the participants scored above 50% in three sections of the questionnaire except in the infant growth assessment skills section, where 19% passed the assessment. However, only 13% scored above 50% in all the sections. Overall, the highest mean score was recorded in the reproductive and sexual health section (62.4%), where the highest number of participants (78%) scored above 50%. In phase two of the study, participants' knowledge and skills increased post-intervention in the second year but decreased significantly two years later in the fourth year, except in the reproductive and sexual health section (contraception). In phase three, the comparative evaluation showed statistically significant differences between the average mean score of participants exposed to the integrated (2019) and traditional curriculum in 2018 ($p = 0.000$, MD = 11.5) and 2017 ($p = 0.000$, MD = 14.8). However, no significant difference was observed between the 2017 and 2018 traditional curriculum exposures ($p \geq 0.05$). The highest mean scores ($p = 0.000$), which were also above the university's pass mark of 50%, were recorded by the 2019 cohort. The highest mean differences were recorded in the reproductive and sexual health components in the three assessments (P = 0.000; MD 2017 = 15.9, MD 2018 = 15.5, MD = 13.6). Overall, the highest mean differences were recorded in the study's reproductive and sexual health components, and the highest positive mean differences in all MCH components were recorded in the 2019 assessment.

Conclusion

Integration of the MCH curriculum content enhanced students' knowledge and skills considerably. In addition, the longitudinal dispersion of curriculum content across a student's years of study reinforced their learning. The study results support the clamour for the training of health care professionals who are deemed fit for service and able to meet the healthcare needs of their communities in line with the goals of the National Development Plan (2030). More active learning strategies such as case simulations, workshops and journal club presentations should be introduced into the curriculum to ensure adequate acquisition and retention of knowledge and skills. More avenues for service learning should be explored.

May 2022

DECLARATION

I declare that:

"*The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape"* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Elizabeth Oyebola Egieyeh

Date: June 2022

Signed _____

DEDICATION

I dedicate this thesis to God almighty whose grace and mercy brought this teenage desire to pass.

To my loving husband (AYLUV), who acknowledges and supports the realisation of my God-given potential.

To my blessed children: Oluwatomisin, Oluwatimilehin, Toluwaniyin and Oluwatemisola. Your love, support, encouragement and resilience made it easy to accomplish this goal.

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RESEARCH OUTPUT

The PhD research project is a Doctoral thesis by publications. The following publications were successfully generated from the research project:

1. Egieyeh, E.; van Huyssteen, M.; Coetzee, R.; Bheekie, A. Evaluating pharmacy students' knowledge and skills in reproductive, maternal, newborn and child health care at a South African university. BMC Med. Educ. 2021, 21, 1–16. https://Doi.org/10.1186/s12909-020-02476-9.

2. Egieyeh, E.O.; Bheekie, A.; van Huyssteen, M.; Coetzee, R. Development and Implementation of an Integrated Framework for Undergraduate Pharmacy Training in Maternal and Child Health at a South African University. Pharmacy 2021, 9, 163. https://Doi.org/10.3390/ pharmacy9040163.

3. Egieyeh, E.; Bheekie, A.; van Huyssteen, M.; Coetzee, R. Comparative evaluation of students' knowledge and skills in maternal and child health: traditional versus integrated curriculum. Pharmacy 2022, 10, 62. https://Doi.org/10.3390/ pharmacy10030062.

RESEARCH OUTPUT

Conferences

1. Elizabeth Egieyeh *, Angeni Bheekie, Mea van Huyssteen, Renier Coetzee. The development, implementation and evaluation of a framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape. Proposal presentation at the First Conference of Biomedical and Natural Sciences and Therapeutics (CoBNeST), 7-10 October 2018. Stellenbosch, Cape Town, South Africa (Podium presentation).

2. Elizabeth Egieyeh *, Angeni Bheekie, Mea van Huyssteen, Renier Coetzee. The development, implementation and evaluation of a framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape. Proposal presentation at the School of Pharmacy, University of the Western Cape, Bellville, South Africa Research Symposium, 03 July 2019. (Podium presentation).

3. Elizabeth Egieyeh *, Angeni Bheekie, Mea van Huyssteen, Renier Coetzee. Perception of pharmacy students and facility nurses to interprofessional education and collaboration in maternal and child health. Towards unity for health (TUFH) 2019. Social accountability: from evidence to action 10 -13 September 2019 – Darwin, Northern Territory, Australia (Oral poster).

4. Elizabeth Egieyeh *, Angeni Bheekie, Mea van Huyssteen, Renier Coetzee. The development, implementation and evaluation of a framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape. Towards unity for health (TUFH) 2022). Moving Forward Together: Unity for Health for All. August 16-19, 2022 Vancouver, British Columbia, Canada (Oral poster).

5. Four final-year student research assistant cohorts attained research skills that emanated from this doctoral study. They completed the research module- Pharmacy Research and Drug Development (PHA 408) at the School of Pharmacy for the years 2017, 2018, 2019 and 2020. Find the group presentations made at the annual School of Pharmacy Research Open Day below.

Final year research project presentations:

I. Daweti Nkolelo, Jubase Neliswa, Luvimbi Aluwani, Sandlana Lulekwa, Williams David, Elizabeth Egieyeh*. Evaluating the competence of the University of the Western Cape 4th year Pharmacy students on Reproductive, Maternal, New-born and Child Health care. Research Open Day 2017. School of Pharmacy, Faculty of Natural Science, University of the Western Cape.

II. Cornelius Kim, Gamieldien Ayesha. Krakri Nomaphelo, Maloka Trudy, Rabie Nikita, Sambo Shereen, Van Neil Sha-Mel, Elizabeth Egieyeh*. Evaluating the effect of the implementation of an integrated Maternal and Child Health curriculum content on the competence of undergraduate pharmacy students at the University of the Western Cape. Research Open Day 2018. School of Pharmacy, Faculty of Natural Science, University of the Western Cape.

III. Chilwan Nazneen, Moola Mohammed, Mthembu Zinhle, Mullah Taskeen, Sikama Khanya, Parker Qayyum, Renier Coetzee, Elizabeth Egieyeh*. Evaluation and comparison of the effect of a maternal and child health curriculum content and design on the knowledge, skill and attitude of 4th-year pharmacy students at the University of the Western Cape. Research Open Day 2019. School of Pharmacy, Faculty of Natural Science, University of the Western Cape.

IV. Aatiqah collins, Aakifah Murison, Odwa Xatalaza, Chanique Langenhoven, Jancke Huisamen, Nabeelah Hendricks, Elizabeth Egieyeh*. Evaluating 4th-year pharmacy students' knowledge and skills retention in an integrated maternal and child health care programme at the University of the Western Cape. Research Open Day 2020. School of Pharmacy, Faculty of Natural Science, University of the Western Cape.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASSAf: Academy of Science of South Africa

BPharm: Bachelor of Pharmacy

CHESP: Community Higher Education Service Partnerships

COVID: Coronavirus disease

EPI: Expanded Programme on Immunisation

FIP: International Pharmaceutical Federation

GPP: Good Pharmacy Practice

HEQC: Higher Education Quality Committee

HIV: Human Immunodeficiency Virus

IMR: Infant Mortality Rate

MCH: Maternal and Child Health

MCM: Maternal and Child Mortality

MCMR: Maternal and Child Mortality Rate

MDG: Millennium Development Goals

MNCH: Maternal, Newborn, and Child Health

MMFR: Maternal Mortality in Facility Ratio

MMR: Maternal Mortality Rate

NMR: Neonatal Mortality Rate

ORS: Oral rehydration solution

PHC: Primary Health Care

RSV: Respiratory syncytial virus

SAMRC: South African Medical Research Council

SAPC: South African Pharmacy Council

SDG: Sustainable Development Goals

SLIP: Service Learning in Pharmacy

SOP: School of Pharmacy

STG and EML: Standard Treatment Guidelines and Essential Medicines List

UWC: University of The Western Cape

UN: United Nations

UNICEF: United Nations Children's Fund

U5MR: Under-Five Mortality Rate

WHO: World Health Organization

CHAPTER ONE: Introduction

1.1 Background

Maternal and child health (MCH) is a continuum of integrated care from adolescence or pre-pregnancy to delivery and childhood (Kerber *et al.*, 2007). Although MCH initially covered the health of pregnant women and children, it has since expanded to include other areas of health care (Bhutta *et al.*, 2014). The areas are interrelated and include reproductive and sexual health care for adolescents to prevent early pregnancies, unsafe sexual practices, sexually transmitted and human immunodeficiency virus (HIV) infections; preconception and sexual health care for women who intend to become pregnant in the future; prenatal, intrapartum and postnatal care for women, and neonatal, infant and child care. Also included are nutritional, mental, immunisation, partner/husband, father, family and community care for mothers and children (Table 1) (Kerber *et al.*, 2007; Bhutta *et al.*, 2008; Tomlinson *et al.*, 2014). The definition was expanded as MCH evolved from a domestic affair to a global public and population health priority due to the high maternal and child mortality rate (MCMR) observed in the 20th century (World Health Organization, 2005; Saturno-Hernández *et al.*, 2019). In addition, the realisation that healthy mothers produce healthy children who are the future of every nation informed the expansion of the definition. Furthermore, healthy pregnancy and postnatal experiences make for a healthy life in the future and reduce healthcare costs for this vulnerable population (Michalow *et al.*, 2015; Stenberg *et al.*, 2021). Further, studies have shown the negative impact of maternal or child death on the well-being and socio-economic status of the family they leave behind (Kes *et al.*, 2015; Ye *et al.*, 2015; Heazell *et al.*, 2016; Zhou *et al.*, 2016; Nuzum, Meaney and O'Donoghue, 2018). Keber et al. (2007) put it all together in their broader definition of the continuum of care as follows:

> The continuum of care for maternal, neonatal, and child health requires access to care provided by families and communities, by outpatient and outreach services, and by clinical services throughout the lifecycle, including adolescence, pregnancy, childbirth, the postnatal period, and childhood. Saving lives depends on high coverage and quality of integrated service-delivery packages throughout the continuum, with functional linkages between levels of care in the health system and between service-delivery packages so that the care provided at each time and place contributes to the

effectiveness of all the linked packages (Kerber *et al.*, 2007).

In many affluent countries that are ranked in the top ten for maternal health where the government funds healthcare and universal coverage has almost been achieved, the foundation of health care is the continuum of care framework (Save the Children, 2006). In addition, patient and practitioner gratification is enhanced with an efficient continuum of care framework (McBryde-Foster and Allen, 2005). In resource-constrained countries with health workforce, system, infrastructure and financial inadequacies and healthcare delivery is neither integrated nor consistent, a practical framework with a well-outlined referral system for obstetric care is essential for maternal survival (Kerber et al., 2007).

Table 1.1 Integrated packages for the health of mothers, newborn babies, and children, with evidence-based interventions along the continuum of care, organised by life cycles and place of service-delivery (Kerber et al., 2007).

Clinical care	**1. REPRODUCTIVE HEALTH** Case management for sexually transmitted illnesses Elective abortion where legal Emergency care Post-abortion care	**2. CHILDBIRTH CARE** Skilled obstetric care at birth and essential care for neonates (hygiene, warmth, breastfeeding) and resuscitation Prevention of maternal to child transmission of HIV Emergency obstetric care and immediate emergency care for newborn babies		**3. NEWBORN BABY AND CHILD CARE** Emergency care Case management of Childhood and neonatal illness Extra care for preterm babies, including Kangaroo mother care Care for children with HIV		
Outpatient and Outreach services	**4. REPRODUCTIVE CARE** Family planning Elective abortion where legal Prevention and management of sexually transmitted illnesses and HIV & AIDS Folic acid and iron	**5. ANTENATAL CARE** Four-visit-focused package that is integrated with: Malaria prevention, intermittent preventive treatment in pregnancy, and insecticide-treated bed nets. Tetanus immunisation Prevention of Maternal to Child Transmission of HIV		**6. POSTNATAL CARE** Promotion of healthy behaviours for mother and baby Early detection and referral of complications Extra visits for preterm babies Prevention of Maternal to Child Transmission of HIV, including appropriate feeding Family planning	**7. CHILD HEALTH CARE** Vaccinations Malaria insecticide-treated bed nets. Nutrition including Vit A and Zinc Care of children with HIV, including cotrimoxazole Integrated Management of Childhood Illness, including the newborn	
	8. FAMILY AND COMMUNITY CARE					
Family and Community care	Adolescent and pre-pregnancy nutrition, including salt iodisation Education Prevention of HIV and sexually transmitted infections	Healthy home behaviours for women in pregnancy, e.g. maternal nutrition, reduced workload, emergency preparedness and recognition of danger signs Community behaviours, emergency transport and funding schemes	Where skilled care is not available, education about clean delivery and simple early care for neonates, including warmth and immediate breastfeeding	Healthy home behaviours including exclusive breastfeeding, hygienic care of cord and skin, extra care for preterm babies Water, sanitation and hygiene Promotion of demand for quality skilled care, recognition of danger signs and appropriate care-seeking Case management of diarrhoea with oral rehydration salts and, where the use of facility care is low, case management of pneumonia, severe malnutrition, neonatal sepsis, and malaria		
	Adolescent and before pregnancy	**Pregnancy**	**Birth**	**Postnatal (mother)**	**Maternal health**	
				Postnatal (Newborn)	**Infancy**	**Childhood**

The World Health Organization (WHO) defines maternal death as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (World Health Organization, 2012). Maternal mortality rate (MMR) is defined as the number of maternal deaths recorded per 100,000 live births during a given period (UNICEF, 2019). Under-five mortality rate (U5MR) is defined as the probability of dying by age five per 1000 live births (UNICEF, 2021). Infant mortality rate (IMR) is the death of an infant before their first birthday per every 1000 live births (WHO, 2021). In addition, infant mortality is regarded as an essential indicator of the overall population health in a society because it responds to socio-economic and health conditions changes (Sartorius and Sartorius, 2014). Neonatal mortality rate (NMR) is the probability of newborns dying within the first 28 days of life per 1000 live births (World Bank, 2019). NMR is regarded as a valuable maternal and neonatal health and care marker.

The introduction of the Sustainable Development Goal (SDGs) 3 in 2015 to build on the unfinished Millennium Development Goals (MDGs) for MCH further emphasises the global attention given to prioritising the MCH population (World Health Organization, 2015). The targets of SDG 3 that are related to MCH indicate that the following recommendations should be achieved by 2030:

1. Target 3.1: the reduction of the global maternal mortality ratio to less than 70 per 100 000 live births.
2. Target 3.2: end preventable deaths of newborns and children under five years of age, with many countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-five mortality to at least as low as 25 per 1000 live births
3. Target 3.7: ensure universal access to sexual and reproductive healthcare services, including family planning, information and education, and the integration of reproductive health into national strategies and programmes.

Many recorded deaths are preventable if access to skilled healthcare workers and timely and quality healthcare services increase (World Health Organization, 2015).

As early as 1978, the Alma-Ata declaration supported the notion of access to quality

healthcare services and workers as it stated that:

> "PHC should be sustained by integrated, functional and mutually supportive referral systems, leading to the progressive improvement of comprehensive health care for all and prioritising those most in need" (WHO-Unicef, 1978).

In addition, the declaration stated that PHC should rely on health workers such as physicians, nurses, midwives, auxiliaries and community workers at local and referral levels as applicable. Where needed, traditional practitioners who are suitably trained socially and technically to work as a health team with orthodox practitioners and respond to the expressed health needs of the community are included in the workforce. The declaration highlighted the importance of healthcare professionals' training. It reinforces the recognition and inclusion of all cadres of MCH providers in the workforce. These actions ensure that uniform and coherent care within the practitioner's scope of practice is provided at every point of care, and referrals are made timeously. Comprehensive integration of all MCH services and providers must be pursued to achieve the SDG 3 goal in MCH (South African National Department of Health, 2021).

1.2 Study rationale

Literature has shown that globally the role of pharmacists in MCH is often underplayed in both the public and private health sectors, as little or no reference is made to their role in the workforce (Anand and Bärnighausen, 2004; World Health Organization, 2014). However, according to the World Health Report (2006), "a health workforce is inclusive of all people engaged in actions whose primary intent is to enhance health" (World Health Organization, 2006). The roles of pharmacists in this healthcare speciality are outlined in the International Pharmaceutical Federation (FIP) policy statement on the effective utilisation of pharmacists in improving MCH (Appendix 1) (International Pharmaceutical Federation (FIP), 2013). The policy alludes to the importance of recognising the role of pharmacists' in MCH, especially in resource-constrained settings with health workforce shortages and high mortality rates, such as sub-Saharan Africa. The roles cut across the continuum of care in MCH and are mainly supportive, preventive and promotional health care services which are the cornerstones of PHC that can eliminate many direct and indirect causes of MCM (Mothupi, Knight and Tabana, 2018). Pharmacists' roles in MCH align with the WHO maternal, newborn, and child health (MNCH) interventions suggested for countries with high burdens of mortality (World Health Organization, 2009).

As part of sub-Saharan Africa, the high maternal and child mortality rate (MCMR) is one of the quadruple disease burdens in South Africa (Hofman and Madhi, 2020). The National Development Plan (NDP) vision 2030 and the National Department of Health have the reduction of maternal and child mortality (MCM) as one of their targets (National Planning Commission, 2013; National Department of Health, 2015). Their target fits in with the National Plan for Higher Education's goal of ensuring that graduates produced from higher education institutions can meet the local needs of society (Ministry of Education South Africa, 2001; National Planning Commission, 2013; Bheekie and Bradley, 2016). With the shortage of healthcare personnel in primary health care (PHC) facilities, undergraduate pharmacy students equipped with the required knowledge and skills can offer services to alleviate the shortage of staff and reduce patient waiting time while learning. Students' participation in work-based learning will strengthen the health system and enable higher education institutions to produce competent graduates conversant with the community's healthcare needs (Bheekie and Bradley, 2016). However, training programmes must be designed to ensure graduates can attain the desired level of competency stipulated by the South African Pharmacy Council Competency Standards Taskforce and Good Pharmacy Practice (GPP) manual for MCH (South African Pharmacy Council, 2017, 2018; Egieyeh *et al.*, 2021).

1.3 Problem statement

Literature search shows that practising pharmacists often feel ill-equipped and uncomfortable rendering MCH services (Bains *et al.*, 2014; Grincevičienė *et al.*, 2015; Albassam and Awad, 2018). Most community pharmacists who are generalist pharmacists alluded to their entry-level degree not preparing them adequately for these speciality services (Bains *et al.*, 2014). In an online cross-sectional, cross-country survey comparing the knowledge, perception and training opportunities of practising and resident pharmacists in Canada, Qatar and Uganda, the overall knowledge in maternal and child health care was described as low at 53.7% (Bains *et al.*, 2014). Although a high client load of mothers and children utilised community pharmacies, a Nigerian study reported that community pharmacists' baseline knowledge was inadequate to provide the required services (Fadiluyi T, Oparah C, 2012). Similarly, in Zimbabwe, the neonatal mortality rate persisted at 29 per 1000 live births (1999 and 2015) despite a decrease (102 to 75) in the under-five mortality rate in the same period.

An assessment of the state of healthcare facilities and the quality of available services indicated significant knowledge and skills gaps among health workers in managing common newborn conditions (Chimhuya *et al.*, 2018). The study recommended developing and implementing an ideal curriculum as recommended by broad stakeholders in the context of national health care needs.

Another study conducted at a Pakistan medical school hypothesised that the reduction of the high maternal and child mortality rate was linked to undergraduate medical students' MCH curriculum content exposure. Non-contextualised, inadequate, inappropriate and fragmented teaching methods were thought to be responsible for the knowledge and skills gap observed in medical graduates (Zaman and Rauf, 2011). The study identified the major determinants of infant mortality in underdeveloped countries through a literature review that spanned ten years. An integrated interdisciplinary MCH module team and curriculum were created, and the result indicated the enhancement of students' knowledge and skills in counselling, antenatal care, and care of newborns and infants (Zaman and Rauf, 2011)

New learning and teaching theories in medical education are promoting transformation from the traditional methods of teaching, where topics are discipline-based, fragmented and taught in silos, to an integrated approach to teaching (Pearson and Hubball, 2012). Cognitive psychology theories of learning support the integrated teaching approach as it is thought to promote contextual and applied learning (Mann, 2002). All topics relevant to MCH which are within the scope of practice of pharmacists should be included in the curriculum and logically delivered or integrated vertically and horizontally to help students understand them in context.

1.4 Aim and Objectives

Aim:

To develop, implement and evaluate a framework for an integrated training programme in MCH for undergraduate pharmacy students at the School of Pharmacy (SOP), University of the Western Cape (UWC).

Objectives:

1. To evaluate the MCH knowledge and skills and assess the curriculum content exposure of final year pharmacy students exposed to a traditional curriculum (Phase 1).

2. To develop and implement a comprehensive and integrated MCH framework for undergraduate training at SOP UWC based on the FIP policy statement on the effective utilization of pharmacists in improving MCH and SAPC GPP on MCH (Phase 2).

3. To evaluate and compare the MCH knowledge and skills of cohorts of final year students exposed to the integrated MCH curriculum to those exposed to a traditional curriculum (Phase 3).

1.5 Research questions

1. Is the traditional MCH curriculum content at the SOP UWC comprehensive for undergraduate pharmacy training?

2. What would the development and implementation of an integrated framework for MCH care for undergraduate pharmacy training entail?

3. Is there a difference in the knowledge and skills of undergraduate pharmacy students exposed to an integrated MCH programme compared to those not exposed to such?

1.6 Thesis outline

The thesis comprises nine chapters. Each chapter has a reference list provided at the end. The chapters are arranged as follows:

Chapter 1: Introduction

Chapter 2: Literature review

Chapter 3: Developing and implementing the integrated MCH framework

Chapter 4: Research design and methodology

Chapter 5: Evaluating Pharmacy students' knowledge and skills in Reproductive, Maternal, Newborn and Child Health Care at a South African university.

Chapter 6: Development and implementation of an integrated framework for undergraduate training in maternal and child health at a South African university.

Chapter 7: Comparative evaluation of pharmacy students' knowledge and skills in maternal and child health: traditional versus integrated curriculum.

Chapter 8: General discussion

Chapter 9: Overall conclusions

1.7 References

Albassam, A. and Awad, A. (2018). Community pharmacists' services for women during pregnancy and breastfeeding in Kuwait: A cross-sectional study, *BMJ Open*, 8(1), pp. 1–8. Doi: 10.1136/BMJ open-2017-018980.

Anand, P. S. and Bärnighausen, T. (2004). Human resources and health outcomes: Cross-country econometric study. *Lancet*, 364(9445), pp. 1603–1609. Doi: 10.1016/S0140-6736(04)17313-3.

Bains, S. *et al.* (2014). Comparison of pharmacist knowledge, perceptions and training opportunities regarding maternal-fetal medicine in Canada, Qatar and Uganda. *Canadian pharmacists journal: CPJ = Revue des pharmaciens du Canada: RPC*, 147(6), pp. 345–51. Doi: 10.1177/1715163514552558.

Bheekie, A. and Bradley, H. (2016). Re-engineering of South Africa's primary health care system: Where is the pharmacist? *South African Family Practice*, 58(6), pp. 242–248. Doi: 10.1080/20786190.2016.1186365.

Bhutta, Z. A. *et al.* (2008). Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *The Lancet*, 372(9642), pp. 972–989.

Bhutta, Z. A. *et al.* (2014). Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? *The Lancet*, pp. 347–370. Doi: 10.1016/S0140-6736(14)60792-3.

Chimhuya, S. *et al.* (2018). Development of a neonatal curriculum for medical students in Zimbabwe - A cross-sectional survey. *BMC Medical Education*, 18(1), pp. 1–9. Doi: 10.1186/s12909-018-1194-2.

Egieyeh, E. *et al.* (2021). Evaluating pharmacy students' knowledge and skills in reproductive, maternal, new-born and child health care at a South African university. *BMC Medical Education*, 21(1), pp. 1–16. Doi: 10.1186/s12909-020-02476-9.

Fadiluyi, T. and Oparah, C. (2012). Potentials of Community Pharmacists to Improve Maternal, Newborn and Child Health. *West African Journal of Pharmacy*, 23(2), pp. 27–33.

Grincevičienė, Š. *et al.* (2015). Experiences of community pharmacists advising pregnant Women. *International Journal of Clinical Pharmacy*, 37(4), pp. 636–644. Doi: 10.1007/s11096-015-0111-6.

Heazell, A. *et al.* (2016). Stillbirths: Economic and psychosocial consequences. *The Lancet*, 387(10018), pp. 604–616. Doi: 10.1016/S0140-6736(15)00836-3.

Hofman, K. and Madhi, S. (2020). The unanticipated costs of COVID-19 to South Africa's quadruple disease burden. *South African Medical Journal*, 110(8), pp. 698–699. Doi: 10.7196/SAMJ.2020.v110i8.15125.

International Pharmaceutical Federation (FIP) (2013). *FIP statement of policy on the effective utilization of pharmacists in improving maternal, newborn and child health (MNCH)*. Dublin. Available:https://www.fip.org/files/fip/publications/FIP_Statement_of_Policy_MNCH_2013_Final.pdf.

Kerber, K. *et al.* (2007). Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *www.thelancet.com*, 370. Available at: www.thelancet.com (Accessed: 9 May 2022).

Kes, A. *et al.* (2015). The economic burden of maternal mortality on households: Evidence from three sub-counties in rural western Kenya. *Reproductive Health*, 12(1)S3 Doi: 10.1186/1742-4755-12-S1-S3.

Mann, K. (2002). Thinking about learning: Implications for principle-based professional Education. *Journal of Continuing Education in the Health Professions*, 22(2), pp. 69–76.

Michalow, J. *et al.* (2015). Triple return on investment: The cost and impact of 13 interventions that could prevent stillbirths and save the lives of mothers and babies in South Africa. *BMC Pregnancy and Childbirth*, 15(1), pp. 1–13. Doi: 10.1186/S12884-015-0456-9.

Ministry of Education South Africa (2001). *National plan for higher education in South Africa*. South Africa: Ministry of Education.

Mothupi, M. C. Knight, L. and Tabana, H. (2018). Measurement approaches in continuum of care for maternal health: A critical interpretive synthesis of evidence from LMICs and its implications for the South African context. *BMC Health Services Research*, 18(1). Doi: 10.1186/s12913-018-3278-4.

National Department of Health (2015). Guidelines for Maternity Care in South Africa', *South African Government*, pp. 1–174. Available at: http://www.health-e.org.za/wp-content/uploads/2015/11/Maternal-Care-Guidelines-2015_FINAL-21.7.15.pdf.

National Planning Commission (2013). *National development plan vision 2030*.

Nuzum, D. Meaney, S. and O'Donoghue, K. (2018). The impact of stillbirth on bereaved parents: A qualitative study. *PloS one*, 13(1). Doi: 10.1371/JOURNAL.PONE.0191635.

Pearson, M. L. and Hubball, H. T. (2012). Curricular integration in pharmacy education', in *American Journal of Pharmaceutical Education*. American Association of Colleges of Pharmacy. Doi: 10.5688/ajpe7610204.

Sartorius, B. K. D. and Sartorius, K. (2014). Global infant mortality trends and attributable determinants - an ecological study using data from 192 countries for the period 1990-2011. *Population Health Metrics*, 12(1), pp. 1–15. Doi: 10.1186/s12963-014-0029-6.

Saturno-Hernández, P. J. *et al.* (2019). Indicators for monitoring maternal and neonatal quality care: A systematic review. *BMC Pregnancy and Childbirth*, 19(1), pp. 1–11. Doi: 10.1186/s12884-019-2173-2.

South African National Department of Health (2021). *South African Maternal, Perinatal, and Neonatal Health Policy*.

South African Pharmacy Council (2017). Good Pharmacy Practice in South Africa', *South African Pharmacy Council*, p.194. Available: http://www.pharmcouncil.co.za/G_PublicationsD.asp.

South African Pharmacy Council (2018). *2018 Competency Standards for Pharmacists in SA, South African Pharmacy Council (SAPC).*

Stenberg, K. *et al.* (2021). Cost-Effectiveness of Interventions to Improve Maternal, Newborn and Child Health Outcomes: A WHO-CHOICE Analysis for Eastern Sub-Saharan Africa and South-East Asia. *International Journal of Health Policy and Management*, 10(Special Issue on WHO-CHOICE Update), pp. 706–723. Doi: 10.34172/IJHPM.2021.07.

Tomlinson, M. *et al.* (2014). Goodstart: A cluster randomised effectiveness trial of an integrated, community-based package for maternal and newborn care, with prevention of mother-to-child transmission of HIV in a South African township. *Tropical Medicine and International Health*, 19(3), pp. 256–266. Doi: 10.1111/tmi.12257.

UNICEF. (2019). *Maternal mortality rates and statistics*. *UNICEF Data*. Available at: https://data.unicef.org/topic/maternal-health/maternal-mortality/ (Accessed: 10 May 2022).

UNICEF. (2021). *Child Mortality - UNICEF DATA*, *Unicef*. Available at: https://data.unicef.org/topic/child-survival/under-five-mortality/ (Accessed: 10 May 2022).

WHO-Unicef. (1978). *Alma-Ata 1978 Primary Health Care*. *International Conference on Primary Health Care*.

World Bank. (2019). *Neonatal mortality rate (per 1,000 live births). World Bank*. Available at: https://www.who.int/data/gho/indicator-metadata-registry/imr-details/67 (Accessed: 23 December 2021).

World Health Organization. (2005). *Mothers and children matter – so does their health. World Health Organization Report*.

World Health Organization. (2006). *The world health report 2006: working together for health*. World Health Organization.

World Health Organization. (2009). *Integrated Management of Pregnancy and Childbirth: WHO Recommended Interventions for Improving Maternal and Newborn Health*. *World Health Organization*.

World Health Organization. (2012). *The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM*, *WHO Library*. Doi: 10.1016/j.clinph.2004.07.025.

World Health Organization. (2014). *A Policy Guide for Implementing Essential Interventions for Reproductive, Maternal, Newborn and Child Health (RMNCH). A multisectorAl Policy comPendium for RMNCH*. Available at: www.who.int (Accessed: 30 June 2021).

World Health Organization. (2015). *Health in 2015: from MDGs, Millennium Development Goals to SDGs, Sustainable Development Goals. World Health Organisation*. Doi: 978 92 4 156511 0.

World Health Organization. (2021). *Child mortality and causes of death. WHO*. Available at: https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/child-mortality-and-causes-of-death (Accessed: 23 December 2021).

Ye, F. *et al.* (2015). Impact of Maternal Death on Household Economy in Rural China: A Prospective Path Analysis. *PloS one*, 10(8). Doi: 10.1371/JOURNAL.PONE.0134756.

Zaman, I. F. and Rauf, A. (2011). Working toward Decreasing Infant Mortality in Developing Countries through Change in the Medical Curriculum. *Asia Pacific Family Medicine*, 10(1), pp. 1–9. Doi: 10.1186/1447-056X-10-11.

Zhou, H. *et al.* (2016). The effect of maternal death on the health of the husband and children in a rural area of China: A prospective cohort study. *PLoS ONE*, 11(6). Doi: 10.1371/journal.pone.0157122.

CHAPTER TWO: Literature review

2.1 Introduction

This chapter reviews the current literature on maternal and child health (MCH) as a global health priority, especially in sub-Saharan Africa. It identifies the importance of easy access to skilled healthcare professionals and adequate healthcare services as interventions needed to reduce the high rate of maternal and child mortality (MCM). The role of pharmacists in MCH as described by international and local regulatory bodies is highlighted, and ways of enhancing these roles are discussed. The advantages of linking undergraduate training to the needs of the health care system are enumerated while ensuring that the curriculum exposure is suitable to produce graduates that would be competent to meet the needs of the local community.

2.2 Maternal and child health: a global health priority

The World Health Organization (WHO) constitution of 1948 had the promotion of MCH and welfare as one of its primary functions (World Health Organization, 2005). The primary health care (PHC) movement launched at Alma-Ata in 1978 expounded on the vulnerability of mothers and children, highlighting them as priority targets for public health action (WHO-Unicef, 1978). MCH and contraception were also central goals in PHC (Bhutta *et al.*, 2008). According to the WHO, PHC is defined as:

> Essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination.

PHC is an integral part of a country's health system, where it is the central function and main focus of the community's overall social and economic development. It is the first level of contact between individuals, the family and the community. With the national health system bringing health care as close as possible to where people live and work, PHC constitutes the first element of a continuing health care process. It addresses the leading health problems in the community by providing promotive, preventive, curative and rehabilitative services accordingly.

By I985, the WHO had published the first maternal mortality estimates (Starrs, 2006). In 1987, a global movement to reduce the burden of maternal death and ill health in developing countries was launched by the Safe Motherhood Initiative in Nairobi, Kenya (Starrs, 2006). In Cairo, at the International Conference on Population and Development in 1994, a 20-year plan of action on universal access to reproductive health services was unfolded based on recognising the rights of women and children. This development altered the rationale for investing in MCH leading to its transformation from a technical concern to a moral and political subject (World Health Organization, 2005). The United Nations Millennium Declaration eight, time-bound Millennium Development Goals (MDGs), was adopted in 2000 as a global partnership to reduce extreme poverty in many nations (World Health Organization, 2015). Two of these goals focused on reducing MCM, indicating the high health priority status accorded to MCH. The link between development, economic growth and MCH was established to underpin its impact on gross domestic profit (Amiri and Gerdtham, 2013).

Remarkable progress was made globally from 1990 to 2015 as maternal and child mortality rates (MCMR) declined by 45% and 53%, respectively (Cha, 2017). However, it fell short of the MDG targets (Bhutta and Black, 2013). The Sustainable Development Goal (SDGs) 3 MCH targets (3.1, 3.2 and 3.7 stated in chapter 1) were introduced in 2016 to build on the unaccomplished MDGs, emphasising the global attention given to prioritising the MCH population (World Health Organization, 2015). The focus of the SDG also shifted from keeping children alive to attaining optimal health through the 'Survive, thrive and transform' global agenda (Goga *et al.*, 2019). In 2017, the global MMR dropped by 38%, from 342 deaths to 211 deaths per 100,000 live births (UNICEF, 2019). The coronavirus disease (COVID-19) pandemic increased MMR from 151 deaths per 100,000 live births in 2019 to 152 deaths in 2020 (Bill & Melinda Gates Foundation, 2021). The projection for 2030 from the current statistics is 133 deaths per 100,000 live births, almost twice the SDG target. The global under-five mortality rate (U5MR) reduced from 93 deaths per 1,000 live births in 1990 to 37 in 2020, a 61% decline (UNICEF, 2021). U5MR requires urgent attention despite the impressive progress as about 13,800 deaths were recorded daily in 2020 alone. In addition, the COVID-19 pandemic disrupted health service delivery that may undo the progress made in the past decades.

Regionally, progress was uneven, with 68% of the global yearly burden of MCM occurring in sub-Saharan Africa- 533 maternal deaths per 100,000 live births or 200,000 maternal deaths a

year (UNICEF, 2019). Due to the high fertility rate in the region, the high mortality rate increases the lifetime risk ("the probability that a 15-year-old girl will die from complications of pregnancy or childbirth over her lifetime") of maternal death to 1in 38 in 2017 compared to 1 in 5,400 in high-income countries (UNICEF, 2019). Similarly, In 2020, the risk of U5M in the region was 15 times higher than what occurred in high-income countries (UNICEF, 2021).

South Africa features among the Sub-Saharan countries with high incidences of MCM (Statistics South Africa, 2015). However, Statistics South Africa reported a national decline in maternal mortality in facility ratio (MMFR). The ratio declined from 105,9 deaths per 100 000 live births in 2019 to 88,0 in 2020 (Stats SA, 2022). The South African Medical Research Council (SAMRC) Rapid mortality surveillance report 2019 & 2020 found that infant mortality rate (IMR) and U5MR reduced to lows of 21 and 28 per 1 000 live births, respectively, in 2020 (Dorrington *et al.*, 2021). The report also showed that in contrast to the increase in mortality rate reported globally due to the COVID-19 pandemic, the strict lockdown restrictions implemented in South Africa resulted in a decrease in the seasonal numbers of registered deaths. In winter, the increases recorded due to respiratory syncytial virus (RSV) and other pneumonia cases and seasonal diarrhoea outbreaks were absent in 2020. The transmission of RSV and other cases of pneumonia among children under five years old was also reduced since schools were closed. The non-pharmaceutical COVID-19 interventions of frequent handwashing and sanitising may have contributed to reducing diarrhoea disease transmission. However, the neonatal mortality rate showed little change at 12 per 1 000 live births. The lockdown effect on both natural and unnatural deaths also led to an apparent decline in the mortality rate of older children and young adolescents aged 5-14 years and older adolescents and youth (the probability of a 15-year-old dying before the age of 25 years).

Before the COVID pandemic, interventions that reduced U5MR included improvements in the prevention and management of paediatric HIV and the provision of newer vaccines while promoting the uptake of the other older vaccines (Goga *et al.*, 2019). Other developments such as treatment of diarrhoea, pneumonia and improved maternal and child nutrition were also instrumental in reducing mortality rates. Many of the deaths recorded are preventable with access to skilled healthcare workers and timely and quality healthcare services (World Health Organization, 2015). A primary intervention to reduce the MCM is pregnancy and infant care health education and promotion programmes (UNICEF, 2019). Adequate knowledge of preconception care will reduce unintended pregnancies (Kallner and Danielsson, 2016). In

addition, scale-up of proven interventions to prevent and treat childhood diseases and reduce maternal mortality and comprehensive integration of available healthcare services must be pursued to achieve the SDG 3 goal in MCH (South African National Department of Health, 2021). One aspect is to examine the role of pharmacists who seem to operate peripherally in the health system to mainstream MCH service delivery. Additionally, to contextualise their potential role in MCH as outlined by international and local regulatory bodies to strengthen the continuum of care.

2.3 Establishing the role of pharmacists in the MCH team

To emphasise the importance of having access to skilled healthcare workers, the WHO policy guide for implementing essential interventions for MCH specifies a policy on human resources for healthcare (World Health Organization, 2014). The policy focuses on deployment and retention, accreditation and certification, authorisation of service provision and task shifting, and MCH training curricula of the workforce to ensure competence, availability and reliability. The members of the workforce are identified as doctors, nurses, midwives, nurse midwives, and other categories of facility-based health workers and community health workers involved in women and children's health care.

Although the policy mentions essential medicines supply and equipment list, it does not specifically identify the role of pharmacists whose traditional role saddles them with these responsibilities. They ensure that critical medication and sterile surgical products and devices required for contraception, vaccines, pregnancy, labour, and delivery are readily available in the pharmacies of hospitals and clinics in the public and private sectors (World Health Organization, 2014; Alrabiah *et al.*, 2017; Ferrand *et al.*, 2017).

Documented evidence of pharmacist-led MCH interventions in community practice in the private sector abounds to show their contribution to MCH (International Pharmaceutical Federation (FIP), 2016; Blair and Menon, 2018; Mospan, 2019; Ayele *et al.*, 2021). As easily accessible healthcare professionals in the community, they are the first point of call outside the family and the first level of care for many patients who are spared the long waiting period experienced at most public facilities (Bheekie *et al.*, 2011; Tsuyuki *et al.*, 2018). The strategic positioning highlights their role in primary care, which can easily be explored and maximised through integration with national programmes to enhance MCH service provision (South

African National Department of Health, 2021). In addition to the traditional role of medicine custodian, other MCH services rendered by community pharmacists include reproductive health care (provision and education on various contraceptive options, including emergency postcoital contraception) (Mospan, 2019). Pre-pregnancy care (folic acid) for women and adolescents (Mathew, 2014), advising on the implications of pre-existing health conditions on pregnancy (Ragland *et al.*, 2010; Brown, Henderson and Sullivan, 2014), pregnancy tests, ensuring medication safety and managing simple pregnancy-related conditions (Grincevičienė *et al.*, 2015; Mospan, 2019), nutritional advice in pregnancy, and malaria prevention (Mangham-Jefferies *et al.*, 2015) are some of the other services. Baby and child health care (encouraging exclusive breastfeeding, immunisation and adequate nutrition for infants and children) (Albassam and Awad, 2018) and identifying women at risk of postpartum depression (Ragland *et al.*, 2010). Health promotion and prevention (i.e. promoting a healthy planned pregnancy and preventing unintended pregnancies) is thus the core of pharmacists' service provision in MCH care (Albassam and Awad, 2018).

The South African Pharmacy Council (SAPC) regulates practice and undergraduate pharmacy education (Bachelor of Pharmacy) which produces generalist pharmacists in South Africa (Ilcewicz *et al.*, 2020). The SAPC Good Pharmacy Practice (GPP) manual stipulates the minimum professional standards required to provide MCH services in a pharmacy, either in the public or private sector (South African Pharmacy Council, 2017). The SAPC GPP aligns with the FIP policy statement and the WHO interventions in the continuum of care for countries with high mortality burdens in stipulating the minimum professional standards required to provide MCH services at the PHC level (Kerber *et al.*, 2007; South African Pharmacy Council, 2017). The stipulated services also align with the continuum of care framework for MCH adapted for the South African health system (Mothupi, Knight and Tabana, 2018). The South African framework highlights the drivers of MCM peculiar to the country and specifies the level of care and the services available at each level in alignment with the re-engineering of PHC (South African National Department of Health, 2012).

For pharmacists to render MCH services within their scope of practice, the SAPC GPP manual emphasises adequate training, knowledge, and skills to provide these services. The physical facility, equipment, documentation, record keeping, and confidentiality necessary to render these services are also highlighted. The stipulated MCH services include immunisation, pregnancy tests, nutrition in pregnancy, baby and child health care, and reproductive health

services. Pharmacists could offer comprehensive reproductive health services if they obtained the necessary supplementary training and registered with the SAPC. However, pharmacists are allowed to initiate emergency postcoital contraception without additional training. In addition, pharmacists can carry out some diagnostic tests such as pregnancy, urine dipstick, human immunodeficiency virus (HIV), blood glucose and cholesterol tests. Skills required for measuring blood pressure, body mass index (BMI), and peak flow meter should be acquired. Smoking cessation, nutrition advice, sexually transmitted infections prevention, and alcohol and drug addiction counselling may be provided in a pharmacy.

In Table 1, the service points for pharmacists in the MCH continuum of care adapted for the South African health system are indicated (Bheekie and Bradley, 2016). Therefore, undergraduate training should provide entry-level pharmacists with the competencies required to render the MCH services expected at the PHC level.

2.4 Integrating the MCH curriculum in undergraduate pharmacy training

Most pharmacy schools or faculties are structured along disciplines such as pharmaceutical chemistry, pharmaceutics, pharmacotherapeutics and social pharmacy, which inform the curricular structure (Pearson and Hubball, 2012). Each disciplinary structure teaches its subject in silos in a traditional curriculum, leading to compartmentalised and fragmented student learning. Students are expected to memorise a large volume of knowledge and regurgitate information that is often not applicable in practice as received from the teacher (Mabope and Meyer, 2014; Tularam, 2018). The teacher-centred teaching leads to students having to decipher the link between the topics taught by each discipline. Studies have shown that practising pharmacists' discomfort with providing MCH services is in part attributable to the traditional curriculum they are exposed to in the undergraduate years of study (Pearson and Hubball, 2012; Bains *et al.*, 2014). A traditional curriculum is thought to hinder contextualised and applied learning, resulting in knowledge and skills gaps among students. The disadvantage of such a curriculum is manifested in practice as patients' problems cannot be categorized into the neat disciplinary silos created by the undergraduate curriculum (Pearson and Hubball, 2012; Yadav *et al.*, 2016).

This is in contrast to an integrated curriculum where the teaching method is contextual,

applied, nestled, connected, and dispersed longitudinally to motivate students and enhance learning, knowledge retention, and application (Custers, 2010; Zaman and Rauf, 2011; Pearson and Hubball, 2012; McBride and Drake, 2016). Integration also helps students think critically and become problem solvers (Poirier, Fan and Nieto, 2016; Al-Hreashy *et al.*, 2018).

Table 2.1 The continuum of care for maternal and child health framework adapted to the South African health system with the service points for pharmacists (***P***) highlighted (Mothupi, Knight and Tabana, 2018).

Regional Hospital	**SPECIALIST OBSTETRIC AND GYNAECOLOGICAL CARE**		**SPECIALIST NEONATAL AND PAEDIATRIC CARE**		**Connecting levels of caregiving**
District Hospital	**REPRODUCTIVE CARE** • Termination of pregnancy • Post-abortion care • Treatment of complicated sexually transmitted infections	**EMERGENCY PREGNANCY AND CHILDBIRTH CARE** Care for high-risk pregnancies and immediate newborn care, including resuscitation		**EMERGENCY NEWBORN AND CHILD CARE** • Care for sick children including those with HIV & AIDS, based on Integrated Management of Childhood illness principles • Extra care for preterm babies, including Kangaroo Mother Care Emergency care for sick newborns	
Outpatient and Maternity Unit	REPRODUCTIVE HEALTH CARE • Family planning- ***P*** • Prevention and care of sexually transmitted infections and HIV & AIDS- ***P*** **(Health education)** • Preconception folic acid- ***P***	**ANTENATAL CARE** • Basic antenatal care package with prevention of HIV mother to child transmission and care for women	**BASIC CHILDBIRTH CARE** • Care for normal deliveries and immediate newborn care, including resuscitation • Prevention of Mother to Child Transmission of HIV	POSTNATAL CARE • Early detection and referral of complications- ***P*** • Support for infant feeding choices- ***P*** • HIV testing for infants at 6 weeks	**CHILD CARE** • Immunisations- ***P*** • Growth monitoring and promotion- ***P*** • Integrated Management of Childhood illness integrated with care of children with HIV including cotrimoxazole
Family and Community	• Adolescent and pre-pregnancy nutrition- ***P*** • Prevention of HIV and sexually transmitted diseases- ***P*** **(Health education)**	• Healthy behaviours, e.g. maternal nutrition, reduced workload- ***P*** **(Health education)** • Danger sign recognition, and emergency preparedness- ***P*** **(Health education)**	• Appropriate home care of babies-appropriate feeding, avoiding hypothermia, hygienic cord/skincare, extra care for preterm babies- ***P*** **(Health education)** • Good nutrition, including complementary feeding- ***P*** **(Health education)** • Demand for key preventive services such as immunisations- ***P*** **(Health education)** • Recognition of danger signs and appropriate care-seeking- ***P*** **(Health education)**		
	Intersectoral:	Improved living conditions- housing, water and sanitation, nutrition Education and empowerment			
	Pre-pregnancy	**Pregnancy**	**Birth**	**Postnatal**	**Childhood**
Connecting caregiving throughout the life cycle					

Curricular integration in pharmacy education reform has received increased attention (Hubball and Burt, 2004; Hutchings, Huber and Ciccone, 2011; Islam and Schweiger, 2015; Jamie, Bows and Gill, 2016; Ryan *et al.*, 2019). It is thought to make educational experiences coherent, relevant, and engaging by connecting diverse disciplines and facilitating higher-order learning (Kadmon *et al.*, 2011; Pearson and Hubball, 2012). Case (1991) defined integration as any deliberate interconnection of separate elements and he explained that curricular integration encompasses the amalgamation of educational goals, content, and procedures (Case, 1991). He defined integration of content as linking the perceptions within and among different subject areas or disciplines. He also described integration to include the formal learning experiences planned by educators and the hidden curriculum (informal) obtainable inside and outside the classroom.

Pearson and Hubball (2012) described these learning experiences as 1) the espoused curriculum that is intended by the educator, 2) the enacted curriculum according to the goals of the programme planners, and 3) the experienced curriculum, which is dependent on students' understanding and uptake of the educational activities (Pearson and Hubball, 2012). Curriculum integration can occur vertically or horizontally. Vertical integration occurs when curriculum content is scaffolded over time, aligned in a logical order while identifying and building on previous knowledge. It could also connect classroom experiences to real-world or practical applications (Pearson and Hubball, 2012). Wijnen-Meijer et al. (2020) defined vertical integration in medical education as "an educational approach that fosters a gradual increase of learner participation in the professional community through a stepwise increase of knowledge-based engagement in practice with graduated responsibilities in patient care" (Wijnen-Meijer *et al.*, 2020). Horizontal integration involves crossing disciplinary boundaries within the allotted time (Pearson and Hubball, 2012; Brauer and Ferguson, 2015).

In a study carried out at a medical school in Pakistan, involving medical tutors in reducing MCM through the sensitisation of undergraduate students to national indices and integration of an MCH curriculum that meets local needs was hypothesised to be a solution to the non-decreasing high maternal and child mortality. The curriculum was revised to focus on local MCM drivers and integrated horizontally across disciplines like obstetrics and gynaecology, paediatrics, community medicine, pathology, and pharmacology. Video demonstrations were used in skills practical sessions and hands-on sessions for neonatal resuscitation. Students made a field visit to a local MCH centre. The post-intervention assessment showed that students had

developed a thorough understanding of the complex factors contributing to infant mortality. Students also demonstrated knowledge and skill in counselling, antenatal care, and care of newborns and infants. Zaman and Rauf (2011) stated that vertical integration within disciplines helps to promote preventive thinking amongst students (Cheng *et al.*, 2000; Zaman and Rauf, 2011). Preventive thinking abilities are also developed when curriculum integration in MCH includes community-based learning and MCH primary health care facility engagements, exposing students to community issues (Cheng *et al.*, 2000; Buckner *et al.*, 2010). Non-traditional teaching and learning approaches encourage students to take responsibility for resourcefully gaining the knowledge required to attend to real-life problems that develop higher-order thinking skills. Therefore, greater emphasis is placed on developing skills, attitudes and values relevant to the subject area (Tularam, 2018).

The need to develop a maternal and child health module and incorporate it into teaching and learning at universities is recognised in many parts of the world, yet, it is often presented as a postgraduate course (Zaman and Rauf, 2011). Unfortunately, generalist pharmacists render MCH services to patients and need to be equipped with the required knowledge and skills to meet society's priority healthcare needs. Pharmacy undergraduates would achieve competence in MCH when the different learning areas are integrated in contrast to the current traditional, fragmented and disjointed learning method along disciplines. Like their medical and nursing counterparts, curriculum integration will lead to relevance in MCH when the curriculum is linked to the needs of the healthcare system in line with the concept of social accountability (Zaman and Rauf, 2011; Bheekie and Van Huyssteen, 2017; Koster, Schalekamp and Meijerman, 2017)

2.5 Social accountability of pharmacy schools in MCH

The global trend in health professional education (HPE) is the inclusion of the principles of social accountability such as relevance, equity, quality and effectiveness in the training, service and research activities of educational institutions. The purpose of HPE is to provide a health workforce that can meet local needs (Frenk *et al.*, 2010; Boelen, Dharamsi and Gibbs, 2012; Academy of Science of South Africa (ASSAf), 2018). Most pharmacy schools are embarking on curriculum review activities to introduce the concept of social accountability through community engagement by linking training to the needs of the healthcare system (Bheekie and Van Huyssteen, 2017). Their educational programmes aim to address priority health concerns

to produce graduates who meet the competencies to serve the local community and population (Pearson and Hubball, 2012; Koster, Schalekamp and Meijerman, 2017).

The WHO defines the social accountability of medical schools as representing "the obligation to direct their education, research and service activities towards addressing the priority health concerns of the community, region, or nation they have a mandate to serve" (Boelen, Dharamsi and Gibbs, 2012). Boelen, Dharamsi et al. (2012) explained the global interest in the social accountability of medical and other health professional schools due to the substantial social resources invested in academic health science institutions. Expectedly, a philosophy of service to humanity is attached to them (Boelen, Dharamsi and Gibbs, 2012). Boelen and Woollard (2009) posit that a label of excellence is attributed to health professional schools committed to responding as best as possible to the priority health needs of the citizens and society through active participation in health system development (Boelen and Woollard, 2009).

Bheekie and van Huyssteen. (2017) described a socially accountable educational institution as one that "aims at training that is contextualised, i.e. localised within a health system, focused on health determinants of a specific population, collaborative through partnerships to improve health and produce graduates who are change agents" (Bheekie and Van Huyssteen, 2017). They used the four values that underpin social accountability to explain that pharmacy schools will gain relevance if their training and activities are aligned with the community's health priorities (Van Huyssteen and Bheekie, 2015).

The concept of community engagement was introduced to higher education in South Africa during its reconstruction and development programme in 1994 (Badat, 2010). The White Paper on the transformation of higher education aims to "promote and develop social responsibility and awareness of social and economic development through community service programmes among students (Ministry of Education South Africa, 2001). Community engagement became an integral and core part of higher education in South Africa. Subsequently, the Higher Education Quality Committee (HEQC) incorporated community engagement and its service-learning component into its national quality assurance systems (Lazarus *et al.*, 2008). The Community Higher Education Service Partnerships (CHESP) initiative implemented community-based service-learning programmes across academic institutions to address priority needs in underserved communities (Bheekie and Bradley, 2016).

Another way to enhance pharmacy schools' relevance in MCH is for pharmacy undergraduates to contribute to health system strengthening like their nursing and medical counterparts by alleviating the shortage of personnel at PHC facilities. Bheekie (2011) suggested that pharmacy undergraduates can be trained to assist in service provision at the MCH units of PHC facilities through service-learning (Bheekie *et al.*, 2011). The concept is supported by Frenk et al. (2010) proposition of the third generation of system-based educational reforms, which adapt essential professional competencies to local needs with global knowledge. The authors submitted that:

"all health professionals in all countries should be educated to mobilise knowledge and engage in critical reasoning and ethical conduct so that they are competent to participate in patient and population-centred health systems as members of locally responsive and globally connected teams" (Frenk *et al.*, 2010).

To achieve this vision, institutional and instructional reforms bordering on transformative learning and interdependence in education are necessary. Educational institutions need to harmonise their curriculum with the health system and train students in competencies relevant to local needs with a global outlook (Frenk *et al.*, 2010). Instructional reforms that promote interprofessional and trans-professional education, enhance collaborative and non-hierarchical relationships and break down professional silos should be adopted. It should also include expanding academic centres to educational systems encompassing networks of hospitals and primary care units.

2.6 Summary

Undergraduate pharmacy training requires curricular transformation in maternal and child health to equip graduates with the required knowledge and skills that would safeguard the health of mothers and children. Such an educational intervention would contribute toward reducing the high maternal and child mortality. In this regard, pharmacy training would become more relevant thereby establishing an alignment toward the values of social accountability.

2.7 References

Academy of Science of South Africa (ASSAf). (2018). *Reconceptualising Health Professions Education in South Africa*. Doi: 10.17159/assaf.2018/0021.

Al-Hreashy, F. *et al.* (2018). A mixed-method evaluation of the views of medical teachers on the applicability of the "infant and young child feeding chapter" in Saudi medical colleges. *BMC Medical Education*, 18(1). Doi: 10.1186/s12909-018-1282-3.

Albassam, A. and Awad, A. (2018). Community pharmacists' services for women during pregnancy and breast feeding in Kuwait: A cross-sectional study. *BMJ Open*, 8(1), pp. 1–8. Doi: 10.1136/bmjopen-2017-018980.

Alrabiah, Z. *et al.* (2017). Knowledge of community pharmacists about the risks of medication use during pregnancy in central region of Saudi Arabia. *Saudi Pharmaceutical Journal*, 25, pp. 1093–1096. Doi: 10.1016/j.jsps.2017.05.005.

Amiri, A. and Gerdtham, U. G. (2013). *Impact of Maternal and Child Health on Economic Growth: New Evidence-Based Granger Causality and DEA Analysis*. Available at: http://devdata.worldbank.org/wdi2011.htm. (Accessed: 30 June 2021).

Ayele, A. A. *et al.* (2021). Involvement and practice of community pharmacists in maternal and child health services: A systematic review. *Research in Social and Administrative Pharmacy*. Res Social Adm Pharm, pp. 643–652. Doi: 10.1016/j.sapharm.2020.07.035.

Badat, S. (2010). The challenges of transformation in higher education and training institutions in South Africa. *Development Bank of Southern Africa*, 8.

Bains, S. *et al.* (2014). Comparison of pharmacist knowledge, perceptions and training opportunities regarding maternal-fetal medicine in Canada, Qatar and Uganda. *Canadian pharmacists journal : CPJ = Revue des pharmaciens du Canada : RPC*, 147(6), pp. 345–51. Doi: 10.1177/1715163514552558.

Bheekie, A. *et al.* (2011). Service learning in pharmacy: Opportunities for student learning and service delivery. *African Journal of Pharmacy and Pharmacology*, 5(23), pp. 2546–2557.

Bheekie, A. and Bradley, H. (2016). Re-engineering of South Africa's primary health care system: Where is the pharmacist? *South African Family Practice*, 58(6), pp. 242–248. Doi: 10.1080/20786190.2016.1186365.

Bheekie, A. and Van Huyssteen, M. (2017). An assessment of social accountability among South African pharmacy schools from public domain information. *African Journal for Physical Activity and Health Sciences (AJPHES)*, 2017(October), pp. 317–334. Available at: http://repository.uwc.ac.za/xmlui/bitstream/handle/10566/3935/Bheekie_An-assessment_2017.pdf?sequence=1&isAllowed=y (Accessed: 10 June 2021).

Bhutta, Z. A. *et al.* (2008). Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *The Lancet*, 372(9642), pp. 972–989. Doi: 10.1016/S0140-6736(08)61407-5.

Bhutta, Z. A. and Black, R. E. (2013). Global maternal, newborn, and child health—so near and yet so far. *New England Journal of Medicine*, 369(23), pp. 2226–2235.

Bill & Melinda Gates Foundation. (2021). *Global Progress and Projections for Maternal Mortality, Goalkeepers*. Available at: https://www.gatesfoundation.org/goalkeepers/report/2021-report/progress-indicators/maternal-mortality/.

Blair, M. and Menon, A. (2018). Community Pharmacy Use by Children across Europe: A Narrative Literature Review. *Pharmacy*, 6(2), p. 51. Doi: 10.3390/pharmacy6020051.

Boelen, C., Dharamsi, S. and Gibbs, T. (2012). The social accountability of medical schools and its indicators. *Education for Health: Change in Learning and Practice*, 25(3), pp. 180–194. Doi: 10.4103/1357-6283.109785.

Boelen, C. and Woollard, B. (2009). Social accountability and accreditation: a new frontier for educational institutions. *Medical education*, 43(9), pp. 887–894.

Brauer, D. G. and Ferguson, K. J. (2015). The integrated curriculum in medical education: AMEE Guide No. 96. *https://Doi.org/10.3109/0142159X.2014.970998*, 37(4), pp. 312–322. Doi: 10.3109/0142159X.2014.970998.

Brown, S., Henderson, E. and Sullivan, C. (2014). The feasibility and acceptability of the provision of alcohol screening and brief advice in pharmacies for women accessing emergency contraception: An evaluation study. *BMC Public Health*. Doi: 10.1186/1471-2458-14-1139.

Buckner, A. V *et al.* (2010). Using Service-Learning to Teach Community Health: The Morehouse School of Medicine Community Health Course. *Academic Medicine*, 85(10), pp. 1645–1651. Doi: 10.1097/ACM.0b013e3181f08348.

Case, R. (1991). There Anatomy of Curricular Integration. *Canadian Journal of Education / Revue canadienne de l'éducation*, 16(2), p. 215. Doi: 10.2307/1494974.

Cha, S. (2017). The impact of the worldwide Millennium Development Goals campaign on maternal and under-five child mortality reduction: Where did the worldwide campaign work most effectively? *Global Health Action*, 10(1), p. 1267961. Doi: 10.1080/16549716.2017.1267961.

Cheng, T. L. *et al.* (2000). Teaching prevention in pediatrics. *Academic Medicine*, 75(7), p. S71.

Custers, E. J. F. M. (2010). Long-term retention of basic science knowledge: A review study. *Advances in Health Sciences Education*, 15(1), pp. 109–128. Doi: 10.1007/s10459-008-9101-y.

Dorrington, R. *et al.* (2021). RAPID MORTALITY SURVEILLANCE REPORT 2019 & 2020. Available at: www.mrc.ac.za/bod/reports.htm (Accessed: 10 May 2022).

Ferrand *et al.* (2017). The roles and the impacts of pharmacists in the management of medical devices at the hospital: A literature review. *Annales Pharmaceutiques Francaises*. Elsevier Masson SAS, pp. 409–419. Doi: 10.1016/j.pharma.2017.05.001.

Frenk, J. *et al.* (2010). Health professionals for a new century: Ttransforming education to strengthen health systems in an interdependent world. *The Lancet*, 376(9756), pp. 1923–1958. Doi: 10.1016/S0140-6736(10)61854-5.

Goga, A. *et al.* (2019). Neonatal, infant and child health in South Africa: Reflecting on the past towards a better future. *South African Medical Journal*, 109(11b), pp. 83–88. Doi: 10.7196/SAMJ.2019.V109I11B.14301.

Grincevičienė, Š. *et al.* (2015). Experiences of community pharmacists advising pregnant Women. *International Journal of Clinical Pharmacy*, 37(4), pp. 636–644. Doi: 10.1007/s11096-015-0111-6.

Hubball, H. and Burt, H. (2004). An integrated approach to developing and implementing learning-centred curricula. *International Journal for Academic Development*, 9(1), pp. 51–65.

Hutchings, P., Huber, M. T. and Ciccone, A. (2011). *The scholarship of teaching and learning reconsidered: Institutional integration and impact*. John Wiley & Sons.

Ilcewicz, H. N. *et al.* (2020). Evaluation of pharmacy students' perceptions of clinical pharmacy in South Africa. *Journal of the American College of Clinical Pharmacy*, p. 22. Doi: 10.1002/jac5.1208.

International Pharmaceutical Federation (FIP). (2016). *An overview of current pharmacy impact on immunisation - A global report. The Hague: International Pharmaceutical Federation (FIP)*. Available at: https://fip.org/files/fip/publications/FIP_report_on_Immunisation.pdf (Accessed: 27 February 2020).

Islam, M. A. and Schweiger, T. A. (2015). Students' perception of an integrated approach of teaching entire sequence of medicinal chemistry, pharmacology, and pharmacotherapeutics courses in PharmD curriculum. *Journal of pharmacy practice*, 28(2), pp. 220–226.

Jamie, K., Bows, H. and Gill, J. (2016). Integration of pharmacogenetic principles as a core thread in the undergraduate pharmacy curriculum. *Pharmacy Education*, 16(1), pp. 64–66.

Kadmon, G. *et al.* (2011). Integrative vs. Traditional Learning from the Student Perspective. *GMS Zeitschrift fur medizinische Ausbildung*, 28(2), pp. Doc28–Doc28. Doi: 10.3205/zma000740.

Kallner, H. K. and Danielsson, K. G. (2016). Prevention of unintended pregnancy and use of contraception—important factors for preconception care. *Upsala Journal of Medical Sciences*, pp. 252–255. Doi: 10.1080/03009734.2016.1208310.

Kerber, K. J. *et al.* (2007). Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *www.thelancet.com*, 370. Available at: www.thelancet.com (Accessed: 9 May 2022).

Koster, A., Schalekamp, T. and Meijerman, I. (2017). Implementation of Competency-Based Pharmacy Education (CBPE). *Pharmacy*, 5(4), p. 10. Doi: 10.3390/pharmacy5010010.

Lazarus, J. *et al.* (2008). Embedding community engagement in South African higher education. *Education, Citizenship and Social Justice*, 3(1), pp. 57–83. Doi: 10.1177/1746197907086719.

Mabope, L. A. and Meyer, J. C. (2014). A problem-based learning BPharm curriculum at a previously disadvantaged university in South Africa. 6(2), pp. 133–137. Doi: 10.7196/AJHPE.287.

Mangham-Jefferies, L. *et al.* (2015). Mind the gap: Knowledge and practice of providers treating uncomplicated malaria at public and mission health facilities, pharmacies and drug stores in Cameroon and Nigeria. *Health Policy and Planning*, 30(9), pp. 1129–1141. Doi: 10.1093/heapol/czu118.

Mathew, C. (2014). *Pharmacists' role in preconception care*. Doi: 10.1016/S1042- 0991(15)30625-3.

McBride, J. M. and Drake, R. L. (2016). Longitudinal cohort study on medical student retention of anatomical knowledge in an integrated problem-based learning curriculum. *Medical Teacher*, 38(12), pp. 1209–1213. Doi: 10.1080/0142159X.2016.1210113.

Ministry of Education South Africa. (2001). *National plan for higher education in South Africa*. South Africa: Ministry of Education.

Mospan, C. M. (2019). Pharmacists as women's health providers: Increasing access to contraception and preconception care. *Journal of the American Pharmacists Association*. Elsevier B.V., pp. 613–614. Doi: 10.1016/j.japh.2019.07.018.

Mothupi, M. C., Knight, L. and Tabana, H. (2018). Measurement approaches in continuum of care for maternal health: A critical interpretive synthesis of evidence from LMICs and its implications for the South African context. *BMC Health Services Research*, 18(1). Doi: 10.1186/s12913-018-3278-4.

Pearson, M. L. and Hubball, H. T. (2012). Curricular integration in pharmacy education. *American Journal of Pharmaceutical Education*. American Association of Colleges of Pharmacy. Doi: 10.5688/ajpe7610204.

Poirier, T. I., Fan, J. and Nieto, M. J. (2016). Survey of pharmacy schools' approaches and attitudes toward curricular integration. *American Journal of Pharmaceutical Education*, 80(6). Doi: 10.5688/ajpe80696.

Ragland, D. *et al.* (2010). Depression and diabetes: Establishing the pharmacist's role in detecting comorbidity in pregnant women. *Journal of the American Pharmacists Association*, 50(2), pp. 195–199.

Ryan, T. J. *et al.* (2019). Design and Implementation of an Integrated Competency-Focused Pharmacy Programme: A Case Report. *Pharmacy*, 7(3), p. 121. Doi: 10.3390/pharmacy7030121.

South African National Department of Health (2012). Re-engineering primary health care for South Africa: Ward Based Primary Health Care Outreach Teams. *National Department of Health*, p. 36.

South African National Department of Health. (2021). *South African Maternal, Perinatal, and Neonatal Health Policy*.

South African Pharmacy Council. (2017). Good Pharmacy Practice in South Africa. *South African Pharmacy Council*, p. 194. Available at: http://www.pharmcouncil.co.za/G_PublicationsD.asp.

Starrs, A. M. (2006). Safe motherhood initiative: 20 years and counting. *The Lancet*, 368(9542), pp. 1130–1132.

Statistics South Africa. (2015) *Millennium Development Goals: Country report 2015*. Pretoria, Statistics South Africa.

Statistics South Africa. (2022). *Maternal mortality rate on the decline in SA | Statistics South Africa, Stats SA*. Available at: https://www.statssa.gov.za/?p=15321 (Accessed: 10 May 2022).

Tsuyuki, R. T. *et al.* (2018). Pharmacists as accessible primary health care providers: Review of the evidence. *Canadian Pharmacists Journal: CPJ*, 151(1), p. 4. Doi: 10.1177/1715163517745517.

Tularam, G. A. P. M. (2018). Traditional vs non-traditional teaching and learning strategies – the case of e-learning! *International Journal for Mathematics Teaching and Learning*, 19(1), pp. 129–158. Available at: https://cimt.org.uk/ijmtl/index.php/IJMTL/article/view/21%0Ahttps://www.cimt.org.uk/ijmtl/index.php/IJMTL/article/view/21.

UNICEF. (2019). *Maternal mortality rates and statistics. UNICEF Data*. Available at: https://data.unicef.org/topic/maternal-health/maternal-mortality/ (Accessed: 10 May 2022).

UNICEF. (2021). *Child Mortality - UNICEF DATA, Unicef*. Available at: https://data.unicef.org/topic/child-survival/under-five-mortality/ (Accessed: 10 May 2022).

WHO-Unicef. (1978). *Alma-Ata 1978 Primary Health Care, International Conference on Primary Health Care*.

Wijnen-Meijer, M. *et al.* (2020). Vertical integration in medical education: the broader perspective. *BMC Medical Education*, 20(1), pp. 1–5. Doi: 10.1186/S12909-020-02433- 6.

World Health Organization. (2005). *Mothers and children matter – so does their health. World Health Organization Report*.

World Health Organization. (2014). *Partnership for Maternal, Newborn & Child Health and WHO. A Policy Guide for Implementing Essential Interventions for Reproductive, Maternal, Newborn and Child Health (RMNCH): A Multisectoral Policy Compendium for RMNCH. World Health Organisation. Geneva, 2014*. Available at: www.who.int (Accessed: 30 June 2021).

World Health Organization. (2015). *Health in 2015: from MDGs, Millennium Development Goals to SDGs, Sustainable Development Goal. World Health Organisation*. Doi: 978 92156511 0.

van Huyssteen, M. and Bheekie, A. (2015). Embedding relevance in pharmacy training: a case study from South Africa. Pharmacy Education, 15(1), pp. 270–274. Available at: http://pharmacyeducation.fip.org/pharmacyeducation/article/view/419 (Accessed: 7 November 2018).

Yadav, P. P. *et al.* (2016). Effectiveness of integrated teaching module in pharmacology among medical undergraduates. *International Journal of Applied and Basic Medical Research*, 6(3), p. 215. Doi: 10.4103/2229-516X.186962.

Zaman, I. F. and Rauf, A. (2011). Working toward Decreasing Infant Mortality in Developing Countries through Change in the Medical Curriculum. *Asia Pacific Family Medicine*, 10(1), pp. 1–9. Doi: 10.1186/1447-056X-10-11.

CHAPTER THREE: Development and implementation of the integrated MCH framework

3.1 Introduction

The content of this chapter was informed by the problem statement in chapter one and the information gathered from the literature review in chapter two. The structures and events that necessitated the integration of the curriculum are discussed. The traditional maternal and child health (MCH)) curriculum is described and differentiated from the integrated curriculum in this chapter. The development and implementation of the integrated MCH framework used in the study are described in this chapter.

3.2 The setting

The University of the Western Cape (UWC) hosts the only School of Pharmacy (SOP) in the Western Cape province of South Africa. The School has four main academic disciplines: pharmaceutics, pharmacy practice, pharmaceutical chemistry, pharmacology and clinical pharmacy, and an experiential learning unit prescribed by the South African Pharmacy Council (SAPC) in the four-years undergraduate Bachelor of Pharmacy (BPharm) programme. The curriculum is presented in modules per semester in each discipline, like many traditional health care programmes (E. O. Egieyeh *et al.*, 2021).

In addition to the on-campus theoretical and laboratory-based teaching, the School's experiential learning programme, Service Learning in Pharmacy (SLiP), aims to provide real-world experiences for students to augment or apply their theoretical knowledge (Bheekie *et al.*, 2011). The SAPC requires every student to complete 400 hours of work-based learning activities across the years of study (Bheekie et al., 2011). To cover the hours, students engaged with the surrounding underserved communities, primary health care (PHC) facilities and hospitals in collaboration with the City of Cape Town and the Metropole District Health Services (Department of Health, Western Cape Province).

An additional way of accumulating the SAPC stipulated hours was an externship activity (training programme in a private sector community pharmacy or PHC facility that counts towards academic grades) carried out during students' holidays. Also, some students opted to work as pharmacist assistants after their second year of study to earn an income or gain experience, but this is not a curriculum requirement.

3.3 The traditional MCH curriculum

Before 2013, faculty from the pharmacy practice discipline presented lectures on contraception, pregnancy care, infant care, communicable diseases, and immunisation which are components of MCH but were presented as individual lectures, not under the overarching MCH umbrella (Table 1). The lectures were presented in the second semester of the third-year level (PHA324) except for contraception lectures which were longitudinally dispersed to the first semester of the fourth year (PHA414). The third-year contraception lectures focused on contraceptive methods in the South African PHC Standard Treatment Guidelines and Essential Medicines List (STG and EML) with a product demonstration practical. The fourth-year lectures covered contraceptive methods not included in the STG and EML.

In 2013, the SAPC called for a curriculum review across pharmacy schools to redesign the curriculum toward clinical competencies required for patient-centred pharmaceutical care as pharmacy moved away from product-centredness (Bheekie and Huyssteen, 2015; Gyllensten, Fuller and Östbring, 2021). As a result of the review, MCH components taught in the third year PHA 324 pharmacy practice module were moved to the new discipline of pharmacology and clinical pharmacy (previously called pharmacology discipline) second year, second-semester module, PHC 223 (Table 1). Although the third-year contraception lecture and product demonstration practical were moved to the new discipline, they retained their allotted teaching hours. They were presented by faculty from the pharmacy practice discipline who also taught the fourth-year content. However, due to reduced class time, the other MCH components such as pregnancy care, infant care, communicable diseases, and immunisation in the pharmacology and clinical pharmacy discipline (PHC223) were taught as a 2-hour crash course. For the new curriculum, a service-learning component at MCH units of PHC facilities in the Cape Metropole was attached to the module and given the designation of service-learning in pharmacy maternal and child health (SLIP MCH).

In the third year of study, an endocrinology lecture on the pharmacology of hormonal preparations further enhanced students' contraception knowledge. Other exposures to these topics may have been references to the importance of health education and medication safety in pregnancy and paediatrics during pharmacotherapy lectures and other disciplines. The MCH curriculum content exposure was concluded with additional contraceptive lectures in the pharmacy practice module (PPR414) during the first semester of the 4th year of study.

3.4 Development of an integrated MCH framework

In 2017, the School responded to government initiatives to reduce the country's high maternal and child mortality rate and be socially accountable by evaluating its MCH curriculum (National Department of Health, 2015). The MCH knowledge and skills of the 2017 final year students exposed to the traditional curriculum were assessed in a baseline study (E. Egieyeh *et al.*, 2021).

The assessment result indicated that students had knowledge and skills gaps in MCH. An intervention was proposed to develop and implement an integrated MCH framework for undergraduate pharmacy training at the school to enhance student learning and competence. The intervention involved identifying existing curriculum content relevant to the MCH continuum of care at each year of study, reviewing it where needed, and scaffolding them vertically and horizontally with new content to develop the integrated framework (Table 1).

Table 3.1 The development of the MCH curriculum at the School of Pharmacy outlining course components of the traditional curriculum (2013-2016) and the integrated curriculum (post-2017) from the 1st to 4th year of study.

	Pre-2013	**2013 – 2016 (traditional curriculum)**	**Post 2017 (integrated curriculum)**
1st year		**Pharmacology and clinical pharmacy:** PHC123- Environmental and nutritional pathology (diarrhoeal disease, deworming, Vitamin A supplementation, pregnancy supplements. (3 hours) Underserved community visit (3 hours) ORS[1] practical (in collaboration with Pharmaceutics discipline) (1 hour)	**Same as 2013-2016**
2nd year		**Pharmacology and clinical pharmacy:** PHC 223- Contraception part 1 Pregnancy and infant care, communicable diseases, immunisation (2 hours crash course) Contraceptive products practical demonstration (2 hours) PHC Facility MCH-SLiP[2] (9 hours)	**Pharmacology and clinical pharmacy:** PHC 213- Urine and blood screening tests and infant growth assessment skills practical (3 hours) PHC 223- Pre-pregnancy and antenatal care, pregnancy care, infant care, communicable diseases of childhood, immunisation against diseases of childhood (EPI[3]), contraception part 1 (15 hours) Contraceptive products practical demonstration (2 hours) SLiP-MCH programme at a PHC [4]facility (9 hours)
3rd year	**Pharmacy practice:** PHA324- Contraception part 1 Pregnancy care, infant care, communicable diseases, immunisation (10 hours) Physical assessment skills practical (3 hours)	**Pharmacology and clinical pharmacy:** PHC 323- Reproductive hormones (2 hours)	**Pharmacology and clinical pharmacy:** PHC 323- Reproductive hormones (2 hours) **Pharmacy practice:** PPR 324- Externship programme at a retail pharmacy or PHC facility (48 hours)
4th year	**Pharmacy practice:** PHA414- Contraception part 2 (2 hours) Urine and blood screening tests practical	**Pharmacy practice:** PPR414- Contraception part 2 (2 hours)	**Same as 2013-2016**

Key: [1]Oral rehydration solution, [2] Service-learning in pharmacy-maternal and child health, [3]Expanded Programme on Immunisation, [4]Primary health care.

3.4.1 Identification and integration of pre-existing MCH content at the first-year level

At the first-year level, previous content in the introduction to pharmacology and clinical pharmacy module (PHC123) environmental and nutritional pathology lectures in the second semester was identified as an MCH component and it was vertically integrated into the framework. The learning objective of the content was to understand the causes of environmental and nutritional pathologies and their prevention. Students learnt about the social determinants of health and the risk factors for disease. One of the focuses of the content was diarrhoea disease, the single highest cause (20%) of under-five deaths that significantly impact maternal and child morbidity and mortality in South Africa (Chola *et al.*, 2015). A SLiP activity was linked to the module where students visited underserved communities living in informal settlements with inadequate water and sanitation infrastructures, increasing diarrhoeal disease incidence. Outbreaks of the disease are recorded during the summer months from November until May, with peaks during February and March (Van Huyssteen and Bheekie, 2015). Students learnt that socioeconomic status influences environmental, nutritional, educational, and personal hygiene factors that affect the prevalence of diarrhoeal disease (Nguyen *et al.*, 2021). Two City of Cape Town environmental health practitioners accompanied students to the communities to have real-life exposure to the social determinants of health and the risk factors for disease as taught in the lectures. SAPC registered faculty guided the students to prepare dry mixtures of oral rehydration salt and sugar pre-packs as a follow-up to the on-campus lectures and SLIP activity. In addition, it was a response to the identified stock-outs of oral rehydration sachets at PHC facilities (Service-learning planning meeting, City Health and UWC, 2013) (Van Huyssteen and Bheekie, 2015). The activity was a portal for the students to engage in a significant health priority intervention according to the South African PHC STG and EML (NDoH South Africa, 2020).

3.4.2 Identification and integration of pre-existing MCH content at the second-year level

Vertical integration occurred within the pharmacology and clinical pharmacy second-year modules. In PHC 213, presented in the first semester, pre-existing curriculum content related to MCH was identified in the clinical skills practical component. Here, students acquired skills in urine pregnancy tests, urine dipstick tests and blood glucose and cholesterol tests which are

essential for regular antenatal care tests or for managing pregnancy-induced or chronic conditions in pregnancy. A new component, infant growth assessment skills practical was introduced into the clinical skills training to expose students to the factors determining average infant growth as a follow-up to the nutritional pathology lectures in the first year. It also prepared students for the second-semester MCH curriculum content, including SLIP-MCH work-based learning.

In the second semester PHC 223 module, pre-existing components of MCH such as pregnancy care, infant care, communicable diseases, and immunisation lectures, were presented as a 2-hour crash course. Contraception lectures, product demonstration practical, and a service-learning component SLIP MCH completed the pre-existing content of the module.

The first intervention was to allocate lecture slots to the MCH topics taught as a crash course. An average of 15 hours is currently assigned to the on-campus MCH preparation. Lecture content was revised and updated to cover the continuum of care and current MCH guidelines. Preconception and adolescent care were highlighted in the framework because of their relevance to teenage pregnancy, a healthcare priority that significantly impacts maternal and child mortality in South Africa (Jonas, 2021). In the immunisation lecture, emphasis was laid on the expanded programme on immunisation (EPI-SA) to reduce childhood diseases in South Africa. The communicable diseases lecture was streamlined to focus on childhood communicable diseases in line with EPI-SA. Pregnancy (antenatal), post-natal, and infant care lectures were revised to align with pharmacists' current scope of practice Department of Health guidelines (NDoH South Africa, 2020).

During the SLiP MCH sessions at public sector PHC facilities in the Cape Metropole, students were required to carry out specific activities which the expanded curriculum had adequately prepared them to do. Each student spent 9 hours (3 hours for three consecutive Fridays from 8:00-11:00 am) at the assigned facility. The MCH nurse facilitated students' activities such as promoting healthy lifestyles and educating mothers on infant growth and care, nutrition, and immunisation, based on the on-campus lecture content exposure. They educated pregnant teenage girls about contraception in response to the country's high incidence of teenage pregnancy. Also, they counselled mothers on medicine administration for preparations like nevirapine; vitamin A drops, oral rehydration solution, deworming agents and infant feeding options. The students participated in infant growth assessment by weighing babies, charting

and interpreting collected information in the infant road to health booklet under the direct guidance of facility nurses. The dry salt and sugar formulation sachets prepared by the first-year students were delivered to the facilities by the second-year students as part of the School's social accountability drive. Students were also encouraged to identify a gap in service delivery that they could meet at each health facility (Bac *et al.*, 2015). SLiP faculty staff helped students tease out the work-based learning at the facility during a reflection session after the three SLIP MCH sessions were concluded. Students submitted an individual reflection report to round off the second-year experiential learning program.

3.4.3 Identification and integration of pre-existing MCH content at the third-year level

In the third year of study, horizontal integration occurred as an MCH component was added to the pre-existing July holiday externship program coordinated by the pharmacy practice discipline in the PPR324 module. Students were required to carry out self-initiated MCH activities similar to the second-year SLiP activities at a retail pharmacy or health facility in their community.

The endocrinology lecture on the pharmacology of hormonal preparations in the second-semester pharmacology and clinical pharmacy module (PHC323) will be integrated into the MCH curriculum in 2022.

3.4.4 Identification and integration of pre-existing MCH content at the fourth-year level

The contraception lectures taught by the pharmacy practice discipline (PPR 414) rounded off the MCH programme in the first semester of the fourth year to conclude the vertical and longitudinal framework integration. Other exposures to MCH content horizontally or otherwise may have been through references to the importance of health education and medication safety in pregnancy and paediatrics offered during other undergraduate course contents, namely pharmaceutics, pharmaceutical chemistry and pharmacotherapy lectures.

3.5 Implementing the integrated MCH framework

To integrate the espoused, enacted, and experienced curriculum, an orientation session was organised for the 2017 second-year students in the first lecture period at the beginning of the second semester when the pharmacology and clinical pharmacy module (PHC223) was scheduled (E. O. Egieyeh *et al.*, 2021). The class was informed that changes had been made to the module's MCH content, which involved developing and implementing an integrated framework scaffolded with other related topics across the four-year programme to promote MCH knowledge and skills competence. The significance of the framework to pharmacists' roles in MCH and the country's high mortality and teenage pregnancy rate was highlighted during the orientation session. Information about the framework's components and the different year levels at which they would be exposed to it was highlighted. The link between each component (topic or activity) and the continuum of MCH care was established at the orientation session and during each contact session by the lecturer (primary author) to ensure clarity and integration of content. Students were invited to participate in a pre and post-intervention study in the second year and a third study two years later in their final year.

The MCH lecture content was delivered according to the School's timetable. Tests and assessments were done within the modules and in line with university guidelines.

3.6 Summary

In the context of this thesis, MCH content integration entailed linking and scaffolding the topics related to the components of the continuum of care in MCH presented in the four-year Bachelor of Pharmacy curriculum at the SOP, University of the Western Cape. Therefore, previously existing and fragmented contents were integrated vertically within the pharmacology and clinical pharmacy discipline and linked horizontally with the modules in the pharmacy practice discipline. Newly developed contents were added to represent every stage of the continuum of care and complete a framework for MCH. Educational goals, content, and procedures were developed to interlink students' espoused, enacted and experienced curriculum. Integrating didactic lectures, practical skills development, and service-learning activities will enable students to develop the knowledge, skills, attitudes, and values desired in a competent pharmacist and MCH service provider (Koster, Schalekamp and Meijerman, 2017).

3.7 References

Bac, M. *et al.* (2015). Medical education and the quality improvement spiral: A case study from Mpumalanga, South Africa. *African Journal of Primary Health Care and Family Medicine*, 7(1), pp. 1–10. Doi: 10.4102/PHCFM.V7I1.738.

Bheekie, A. *et al.* (2011). Service learning in pharmacy: Opportunities for student learning and service delivery. *African Journal of Pharmacy and Pharmacology*, 5(23), pp. 2546–2557..

Bheekie, A. and van Huyssteen, M. (2015). Be Mindful of Your Discomfort: An Approach to Contextualized Learning. *International Journal of Research on Service-Learning and Community Engagement*, 3(1), p. 21560. Doi: 10.37333/001C.21560.

Chola, L. *et al.* (2015). Reducing diarrhoea deaths in South Africa: costs and effects of scaling up essential interventions to prevent and treat diarrhoea in under-five children. *BMC Public Health*, 15(1), p. 394. Doi: 10.1186/s12889-015-1689-2.

Egieyeh, E. *et al.* (2021). Evaluating pharmacy students' knowledge and skills in reproductive, maternal, new-born and child health care at a South African university. *BMC Medical Education*, 21(1), pp. 1–16. Doi: 10.1186/s12909-020-02476-9.

Egieyeh, E. O. *et al.* (2021). Development and Implementation of an Integrated Framework for Undergraduate Pharmacy Training in Maternal and Child Health at a South African University. *Pharmacy*, 9(4), p. 163. Doi: 10.3390/pharmacy9040163.

Gyllensten, H., Fuller, J. M. and Östbring, M. J. (2021). Commentary: how person-centred is pharmaceutical care? *International Journal of Clinical Pharmacy*, 1, pp. 1–6. Doi: 10.1007/S11096-021-01332-0/FIGURES/1.

Van Huyssteen, M. and Bheekie, A. (2015). Embedding relevance in pharmacy training: a case study from South Africa. *Pharmacy Education*, 15(1), pp. 270–274. Available at: http://pharmacyeducation.fip.org/pharmacyeducation/article/view/419 (Accessed:7 November 2018).

Jonas, K. (2021). *Teenage pregnancy during Covid-19 double pandemic. SAMRC*. Available at: https://www.theindependent.co.zw/2021/09/10/teenage-pregnancy-during-covid-19- double-pandemic/.

Koster, A., Schalekamp, T. and Meijerman, I. (2017). Implementation of Competency-Based Pharmacy Education (CBPE). *Pharmacy*, 5(4), p. 10. Doi: 10.3390/pharmacy5010010.

Nguyen, T. Y. C. *et al.* (2021) 'Diarrhoea among children aged under five years and risk factors in informal settlements: A cross-sectional study in Cape Town, South Africa', *International Journal of Environmental Research and Public Health*, 18(11). Doi: 10.3390/ijerph18116043.

South Africa National Department of Health. (2015). Guidelines for Maternity Care in South Africa. *South African Government*, pp. 1–174. Available at: http://www.health-e.org.za/wp-content/uploads/2015/11/Maternal-Care-Guidelines-2015_FINAL-21.7.15.pdf.

South Africa National Department of Health. (2020). Standard Treatment Guidelines and Essential Medicines List for South Africa: Primary Healthcare Level 2020 edition'. Available at: https://www.knowledgehub.org.za/e-library (Accessed: 23 January 2022).

CHAPTER FOUR: Research design and methodology

4.1 Introduction

This chapter describes the study design and methods employed in accomplishing the research question, aim and objectives outlined in chapter one. The content describes the processes used for collecting the data used in evaluating and comparing the different phases of the framework developed in chapter three. Other contents discussed in this chapter include the study site, population, sampling strategy with the inclusion and exclusion criteria for participant recruitment, data management and analysis, and ethical considerations.

4.2 Study design

The research project was designed as a descriptive, quantitative, longitudinal, non-randomised program evaluation study to assess undergraduate pharmacy students' maternal and child health (MCH) knowledge and skills in three phases.

1. The first phase (phase 1) was an evaluation study of the baseline knowledge of final-year pharmacy students exposed to a traditional curriculum.
2. The second phase (phase 2) was a longitudinal cohort study of the knowledge and skills of undergraduate pharmacy students exposed to an integrated curriculum from the second to the fourth year of study.
3. The third phase (phase 3) was a comparative evaluation of the knowledge and skills of a cohort of final-year pharmacy students exposed to a traditional curriculum to those exposed to an integrated one.

The study followed an iterate research cycle. Student evaluations were repeated over a few semesters (2017 to 2019) until the process was completed. New ideas gained from previous activities were added to the intervention in the subsequent year to improve the learning and teaching of MCH.

4.3 Study site

The study took place at the School of Pharmacy (SOP), University of the Western Cape (UWC). The MCH educational intervention was conducted in lecture venues for didactic lectures and data collection, laboratories for clinical skills practicals such as infant growth assessment sessions, case labs and contraceptive product demonstrations.

4.4 Study population

Due to the longitudinal nature of the study, cohorts were recruited from the following student population from 2017 to 2019:

1. Cohort 1: 2017 second-year undergraduate pharmacy students.
2. Cohort 2: 2017 fourth-year undergraduate pharmacy students.
3. Cohort 3: 2018 fourth-year undergraduate pharmacy students.
4. Cohort 4: 2019 fourth-year undergraduate pharmacy students.

Cohorts 1 and 4 are the same set of students who were in the second year of study in 2017 and the fourth year in 2019.

4.4.1 Development of student researchers

As part of the requirements for completing the BPharm degree at the SOP, about five or six final year students per study year (2017, 2018, 2019, 2020) worked under the supervision of the primary researcher to develop their research skills. Each research group was allocated an MCH subproject and trained as student researchers. They participated in questionnaire development, data collection and minor analysis relevant to their research topic. As a result, the project birthed four honours level sub-projects during the research study period from 2017 to 2020 (see the research titles and presentation under research output in the preliminary section).

4.5 Study sampling

4.5.1 Sampling strategy, sample size and selection criteria

A non-probability sampling method was employed throughout the research. A convenience, non-randomised sampling method was used as data collection was done with available and consenting subjects. Therefore, the sample size depended on the number of students present in the class and willing to participate in the study.

4.5.1.1 Inclusion criteria

1. Cohort 1: 2017 second-year undergraduate pharmacy students.
    i. Students who were registered for the first and second-semester pharmacology and clinical pharmacy modules, PHC 213 and 223.
2. Cohorts 2 and 3: 2017 and 2018 fourth-year undergraduate pharmacy students.
    ii. These cohorts were exposed to the traditional curriculum. The inclusion criterium was registration as final year students.
3. Cohort 4: 2019 fourth-year undergraduate pharmacy students.
    i. Registration as final year students.
    ii. Participation in the 2017 second-year first and second-semester pharmacology and clinical pharmacy modules, PHC 213 and 223.
    iii. Participation in the 2018 third-year externship programme.

4.5.1.2 Exclusion criteria

1. Cohorts 2 and 3: 2017 and 2018 fourth-year undergraduate pharmacy students.
    i. Students who were not registered as final year students.
2. Cohort 4: 2019 fourth-year undergraduate pharmacy students.
    i. Students who were repeating the fourth-year pharmacology module
    ii. Students who did not participate in the 2018 third-year externship programme.
    iii. Students who did not participate in the 2017 second-year pharmacology and clinical pharmacy modules, PHC 213 and 223 pre and post-intervention tests.

4.6 Data collection and analysis

4.6.1 Questionnaire development

Two 34-item, paper-based, structured questionnaires (Appendix 2 and 3) were developed after a thorough review of related published studies that evaluated pharmacist knowledge and skills in MCH (Zaman and Rauf, 2011; International Pharmaceutical Federation (FIP), 2013; Bains *et al.*, 2014; Albassam and Awad, 2018). One of the two questionnaires was designed for the second-year cohort and the other for the fourth-year cohort. The second-year questionnaire had three sections; A, B, and C while the fourth-year questionnaire had an additional section, D. Both questionnaires had the same structure but slight differences in some sections. Although similar questions were included in the two questionnaires, the sentences in the second-year questionnaire were simplified for ease of understanding.

Section A of the questionnaire asked for information about participants' demographic details, which included age, gender and parenting status. In addition to these questions, the second-year questionnaire inquired about participants' first language and previous exposure to any MCH content outside of the School's curriculum. The final year questionnaire contained additional details about participants' locum experience (a person who substitutes for another person from the same profession to fulfil their duties temporarily).

Section B of the questionnaire had three sub-sections with 28 items that assessed participants' knowledge of MCH. The items consisted of 18 multiple-choice (one mark per question) and 16 short answer questions (one mark per response) which counted for 28 marks. The first subsection had reproductive and sexual health questions centered on contraception, with nine items worth nine marks. Secondly, a maternal and antenatal care subsection assessed participants' preconception and pregnancy care knowledge with ten items worth 17 marks. Lastly, a neonatal and child care section covering infant care and nutrition, childhood diseases and immunization, with nine items totaling 12 marks. An 'I do not know' option was added to the multiple-choice questions in the fourth-year questionnaire to minimize guessing.

Section C had six short answer questions worth eight marks that assessed participants' infant growth assessment skills and knowledge in a written format. In the 2017 and 2018 fourth-year assessments, section D assessed participants' MCH traditional curriculum exposure across the undergraduate study to contextualize the knowledge and skills evaluation outcomes. Participants required a score of 50% in

each knowledge subsection and the skills section of the questionnaire to pass the assessment. A 50% score is the minimum pass mark for most university modules and represents the lowest proper knowledge of module content. Therefore, the MCH assessments were aligned with the university's 50% pass mark.

4.6.2 Pilot test

In 2017, the questionnaire was piloted on a convenience sample of eight final year students in a closed- book, written assessment supervised by the primary researcher and student researchers at a predetermined campus venue. Participants were required to answer all the questions in the questionnaire. They were also required to complete a pilot test questionnaire appraisal using a structured form (Appendix 4) where the level of clarity and conciseness of the items in the pilot questionnaire were assessed. About 45 minutes was required to complete the questionnaire. The eight participants were excluded from the final study.

4.6 2.1 Results

As the pilot study was not intended to measure participants' knowledge and skills in MCH but to assess the appropriateness and clarity of the questions and timing of the study, the focus was on the responses obtained from the post-pilot data as described below:

Of the eight students who participated in the pilot test, some found the questions clear and unambiguous (n = 5), while the others found some questions vague (n = 3). Participants' opinions were equally divided on the appropriate number of questions. Many participants found the questions difficult and struggled to understand abbreviations such as MUAC (mid-upper arm circumference) and terms like mastitis (n = 5). Generally, the participants agreed that the questions were appropriate; however, they struggled to answer some questions because they were either not exposed or adequately exposed to specific maternal and child health care topics, or they had forgotten some of the content. Participants suggested that the number of questions should be reduced, more immunization questions should be included, and the skills assessment section should be omitted as, in their opinion, it was not relevant to pharmacists' scope of practice. They suggested that the instructions on the curriculum assessment tool (Section D) should be simplified. All the participants stated that the time was sufficient to read the consent letter and complete the questionnaire and curriculum assessment tool. The participants found the information sheet and consent form easy to read and understand. The majority of the participants saw a 50% pass mark in each knowledge subsection and skills section as reasonable. A final questionnaire was prepared based on the

comments received from the pilot study participants and additional comments and suggestions from four faculty members, such as removing the “I do not know” option from the MCQs in the second-year questionnaire.

4.6.3 Validity and reliability

The content validity of the 34-item questionnaire was reviewed and verified by four faculty members who were knowledgeable in the subject area, five researcher assistants and eight final-year students. They assessed the spread of the items, appropriateness, readability and clarity. However, a pilot study was carried out with one group of subjects to measure the questionnaire once and test its reliability.

Although the scoring agreement was not calculated, it was ensured by training the research assistants on what to do when grading the instruments, by providing a moderated memorandum and by ensuring that graded questionnaires were verified. The primary researcher resolved all the discrepancies among scorers and verified all the graded questionnaires. In addition, to ensure reliability, the same procedure was used for data collection throughout the study, which was done during a regular lecture time slot, timed and supervised appropriately. The content covered in the questionnaire was part of a university module. It served as a tool to assess the knowledge and skills acquired by participants from curricular activities. The medium of communication was English which is also the official language used at the university. Cronbach alpha was calculated to estimate the internal consistency and reliability of the items in a test. It was used to indicate the dependence of test scores on the group or general factors rather than item-specific ones. A high score indicates the internal consistency and reliability of the test.

4.7 Recruitment and data collection

In studies involving fourth-year students, information about the study was communicated to the students through verbal announcements made in class by their classmates who were student researchers. Second-year students were informed of the study and the phases that would involve their participation by the primary researcher during lectures and through emails. The primary researcher sent emails to the participating class through the university’s electronic communication platform. Students were encouraged to participate in the study as the outcome would help to improve student learning in MCH at the School. They were informed that participation was voluntary and that not participating in the survey would not negatively affect their course assessments.

Data was collected from the various cohorts of pharmacy students involved in the study at different times according to the scheduling of relevant MCH topics or activities on the School's timetable from 2017 to 2019 (Figure 1). Data was collected through face-to-face self-administered paper questionnaire surveys. Electronic or online questionnaire surveys were not used in this study due to the low response rate it usually generates (Ebert et al., 2018).

4.7.1 2017 Second-year students (cohort 1)

Second-year pharmacy students who registered for the pharmacology and clinical pharmacy module (PHC 223) were recruited for the study in the first week of the second semester during regular class time and designated venue before the MCH lectures were delivered. The primary researcher explained the purpose of the study to the class and informed them of how and when their participation would be required in the pre and post-intervention and final year assessments two years later. Interested students were provided with the study information sheet and consent form to complete and return to the researcher. A convenience sample of 96 students consented to participate in the study. They completed the questionnaire in the pre-intervention assessment to evaluate their baseline knowledge. Disappointingly, only 47 of the students participated in the post-intervention assessment eight weeks after the didactic lectures, contraception product demonstration practical, SLiP MCH sessions at the PHC facilities and reflection sessions were concluded. Consequently, the same number of students was eligible for the final year assessment two years later, in 2019 (cohort 4).

4.7.2 Fourth-year students (cohorts 2, 3 and 4, N = 142)

Data was collected in the first semester during a predetermined lecture period at a university-allocated venue where all final-year students were meant to be in attendance. With the exemption of the student researchers and the students who participated in the pilot test in the 2017 study (cohort 2), all other students were asked to indicate if they would like to participate. Consenting students, (n =54 in 2017, n = 41 in 2018, n = 47 in 2019) received the study information sheets and completed the consent form. After that, a questionnaire was handed out to each participant to self-administer and return to the researchers in a closed book, exam type of supervised assessment for 60 minutes.

However, in 2019 (cohort 4), a purposive sample of the 47 students who participated in the 2017 second year (cohort 1) pre and post-intervention assessment were recruited for the assessment.

4.8 Data evaluation and analysis

Three student researchers marked the completed questionnaires using a structured memorandum. After that, two student researchers moderated the marked questionnaires before the marks were finalised and captured. Data were analysed descriptively using frequencies and percentages. Data was captured on an Excel spreadsheet and exported into the Statistical Package for the Social Sciences (SPSS) version 26 for analysis.

In the 2017 final year (cohort 2) phase 1 assessment, students' exposure to MCH curriculum content (section D) was determined descriptively in frequencies and percentages. Non-parametric statistical analysis was used because the data was not normally distributed. Spearman's correlation (r) was conducted to explore the strength of the relationship between ranked continuous variables. Chi-square was used to compare the relationship between categorical variables [demographic characteristics and students pass (≥50%) and fail (< 50%) categories in reproductive and sexual health, maternal and antenatal care, and neonatal and child care]. Parametric analyses were used for study phases two and three because the data was normally distributed.

The statistical analyses carried out included one-sample t-test, which compared participants' mean scores with an average of 50% to determine the pass rate. In the phase two assessment, one-way repeated-measures analysis of variance (ANOVA) and post hoc tests were used to determine the difference in participants' mean scores in the three assessments. In the phase three assessment, one-way between-groups analysis of variance (ANOVA) and post hoc tests compared the integrated and traditional curricula. Stepwise linear regression analysis was used to predict the effect of participants' demographics on knowledge and skills acquisition and retention in the two phases. Cronbach's alpha was calculated to quantify the test reliability.

4.9 Ethical and legal considerations

Ethics approval was obtained from the University of the Western Cape Biomedical Research Ethics Committee, the Western Cape Provincial Health Research Committee and the UWC Registrar's office before the study was conducted (HS/17/5/12, 24/07/2017; BM18/4/8). The study was conducted according to the principles stated in the declaration of Helsinki (General Assembly of the World Medical Association, 2014). Participation in the study was voluntary and participants could decide to withdraw from the study at any point. Participants' anonymity was ensured by the use of unique identifiers.

Participants were provided with the study information sheet and written consent was obtained before participation. Data collection tools and consent forms were stored separately, safely and securely in the primary researcher's office. Data from the study was not added to the public domain because it is the property of the university. Participants' personal information was not divulged to the public during data collection or result dissemination in line with the Protection of Personal Information Act (POPIA). Risks to study participants were minimal as the anonymity protection will ensure confidentiality. No direct benefits for the study participants were anticipated. According to the principle of non-maleficence, no subjects participating in the study were subjected to physical and/or academic harm of any kind pre or post-completion of the questionnaires. According to the principle of beneficence, the study intended to "do good" by establishing the advantages of an integrated MCH framework in the pharmacy curriculum and profession or to do good by any other prospective means. Information was not obtained from vulnerable individuals that were unable to protect their own interests. Cultural differences were noted and treated with the utmost respect.

As a student-dependent study, participant recruitment was carried out during regular class periods. Participants did not directly benefit from the study. However, students were informed that participation was voluntary and that they could leave the study at any point. They were also assured that not participating in the study would not negatively affect their academic grades. Likewise, participating in the study would not earn them extra favours from the researcher. The risks to study participants were minimal as anonymity protection ensured confidentiality. Participants' anonymity was guaranteed by using unique identifiers and compliance with the Protection of Personal Information Act (POPIA). Data collection tools and consent forms were stored separately and securely in the primary researcher's office.

4.10 Summary

The chapter described the questionnaire development, data collection, and statistical analysis used to obtain the results published in the articles included in thesis chapters five, six, and seven.

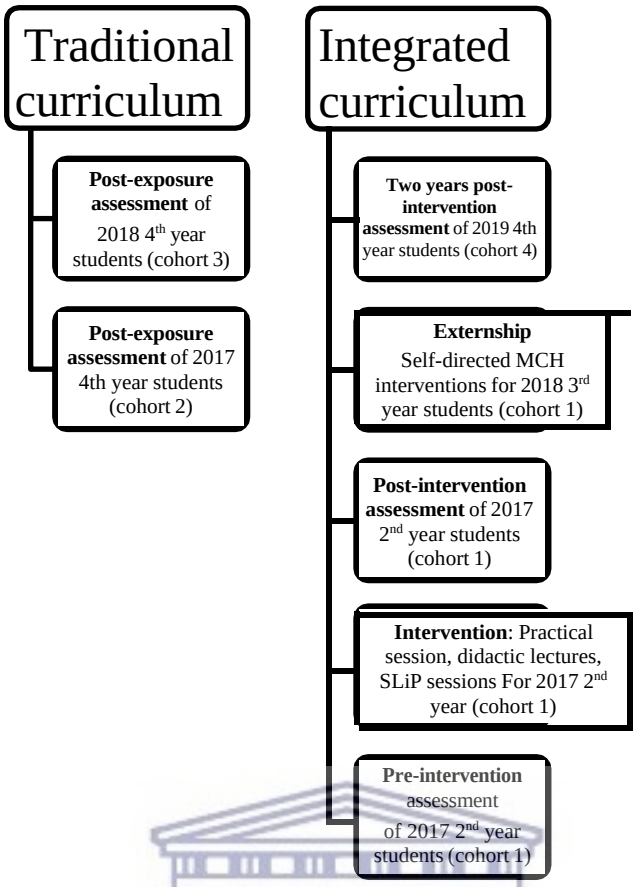

Figure 4.1 The data collection process for the 2017 and 2018 fourth-year students exposed to a traditional curriculum and the 2017 2nd year students exposed to an integrated curriculum through to the 4th year in 2019.

4.11 References

Albassam, A. and Awad, A. (2018). Community pharmacists' services for women during pregnancy and breastfeeding in Kuwait: A cross-sectional study. *BMJ Open*, 8(1), pp. 1–8. Doi: 10.1136/bmjopen-2017-018980.

Bains, S. *et al.* (2014). Comparison of pharmacist knowledge, perceptions and training opportunities regarding maternal-fetal medicine in Canada, Qatar and Uganda. *Canadian pharmacists journal: CPJ = Revue des pharmaciens du Canada : RPC*, 147(6), pp. 345–51. Doi: 10.1177/1715163514552558.

Ebert, J. F. *et al.* (2018). Paper-or web-based questionnaire invitations as a method for data collection: Cross-sectional comparative study of differences in response rate, completeness of data, and financial cost *Journal of Medical Internet Research*, 20(1). Doi: 10.2196/jmir.8353.

General Assembly of the World Medical Association. (2014). *World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. J Am Coll Dent*.81(3):14-18. PMID: 25951678.

International Pharmaceutical Federation (FIP). (2013). *FIP statement of policy on the effective utilization of pharmacists in improving maternal, newborn and child health (MNCH)*. Dublin. Available: https://www.fip.org/files/fip/publications/FIP_Statement_of_Policy_MNCH_2013_Final.pdf.

Zaman, I. F. and Rauf, A. (2011). Working toward Decreasing Infant Mortality in Developing Countries through Change in the Medical Curriculum. *Asia Pacific Family Medicine*, 10(1), pp. 1–9. Doi: 10.1186/1447-056X-10-11.

CHAPTER FIVE: Evaluating pharmacy students' knowledge and skills in reproductive, maternal, newborn and child health care at a South African university

In this chapter, a research paper entitled:

"Evaluating pharmacy students' knowledge and skills in reproductive, maternal, newborn and child health care", is presented. It was published as an open-access research article in BioMed Central, BMC Medical Education. (2021) 21:34 https://Doi.org/10.1186/s12909-020-02476-9. It has been used in this thesis as an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

The research paper presented in this chapter evaluated the MCH knowledge and skills of 54 final-year pharmacy students that were exposed to a traditional, fragmented MCH curriculum content across their four years of study from 2014 to 2017 (cohort 2) in the first phase of the research project (phase 1). A self-administered structured questionnaire was developed from similar studies and piloted on eight final-year students before it was used for participants' assessment. The final questionnaire had sections that assessed participants' knowledge of reproductive and sexual health (RSH), maternal and antenatal care (MAC), neonatal and child care (NCC) and skills related to infant growth assessment procedures. A score of 50% in each section of the questionnaire indicated a pass. The result showed that only seven of the 54 participants passed the assessment indicating a knowledge and skills gap in MCH.

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RESEARCH ARTICLE Open Access

Evaluating pharmacy students' knowledge and skills in reproductive, maternal, newborn and child health care at a South African university

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Abstract

Background: Maternal and child mortality is a global concern and one of South Africa's quadruple burdens of disease. As easily accessible frontline healthcare workers, pharmacists play an important role in the continuum of maternal and child health (MCH) care according to recommendations by international health regulatory bodies. Pharmacy schools are obliged to train pharmacy students to meet the priority health needs of the population so that graduates are 'fit for purpose'. The baseline study aimed to evaluate the knowledge and skills of 2017 final year pharmacy students who were exposed to a fragmented MCH care curriculum at a university in South Africa to inform curriculum review.

Methods: A descriptive, quantitative, non-randomized study was conducted among final year pharmacy students using a self-administered structured questionnaire. The questionnaire was designed in sections to assess participants' knowledge of reproductive and sexual health (RSH), maternal and antenatal care (MAC), neonatal and child care (NCC) and skills related to infant growth assessment procedures. Data was analysed descriptively using frequencies and percentages. A score of 50% in each section of the questionnaire indicated a pass. Participants assessed their exposure to MCH topics in the curriculum.

Results: Of the 89 available students, 61% consented to participate in the study. The average scores attained for each section were; 62.4% for RSH, 54.5% for MAC, 50.4% for NCC and 25.3% for infant growth assessment. The pass rate was 78% for RSH, 56% for MAC, 57% for NCC, and 19% for infant growth assessment. About 13% of the participants passed all the knowledge and the skills sections. Age, gender, being a parent or Doing locums did not have any influence on participants' performance. Participants reported that they had more on-campus curriculum content exposure to RSH compared to other MCH care topics.

Conclusion: Final year pharmacy students showed adequate knowledge of RSH with adequate curriculum exposure. Average knowledge of MAC, NCC and poor skills in infant growth assessment which corresponded to curriculum exposure was observed. The results suggest the need for improvement in the current curriculum in the affected areas to adequately equip students to render desirable services.

Keywords: Curriculum, Final year pharmacy students, Knowledge and skills, Maternal and child health care, Pharmacy education, South Africa

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Background

Maternal and child health care is a continuum of integrated care which spans from adolescence or pre-pregnancy to delivery and childhood [1]. Maternal and child health care became a global concern with the high incidence of maternal and child mortality observed in the past three decades. Complications during pregnancy and childbirth are a leading cause of death. Globally, annual unintended pregnancies contribute to maternal and child mortality through 25 million unsafe abortions, 47,000 maternal deaths, 2.7 million neonatal deaths and 2.6 million stillbirths [2]. Most maternal and child mortality incidences are avoidable through provision of required care and management at every phase of the continuum of care [3].

The United Nations' Sustainable Development Goals (SDG) 2030 has targets for reducing maternal mortality, under 5 mortality and providing universal access to sexual and reproductive health care services [3]. These targets are focal points that are aimed at increasing the global declines observed between 1990 and 2015 [3]. Sub-Saharan Africa and South Asia have the slowest reduction in maternal and child mortality rates and account for the highest burden of deaths in the world [3]. As part of sub-Saharan Africa, South Africa is one of the 74 countries globally that needs accelerated progress to meet the SDG targets [4]. In 2015, its maternal mortality rate declined to 121 per 100,000 live births while under-5 mortality rate stood at 30.2 but increased to 42 per 1000 live births in 2016 [5]. The observed decline was attributed to improved access to skilled health care professionals and healthcare services [3].

Causes of maternal and child mortality are classified either as direct or indirect obstetric causes. The World Health Organisation's (WHO) International Classification of Diseases (ICD-10) for maternal mortality (ICD-MM) and perinatal mortality (ICD-PM) is intended to aid concentration on relevant interventions [6, 7]. Obstetric causes of neonatal mortality were preterm buwcirth complications, infections, intrapartum-related complications, congenital anomalies while post-neonatal mortality was attributed to pneumonia, diarrhoea, measles, and malaria [6]. Obstetric causes of maternal mortality included hypertension and infections in pregnancy, obstetric haemorrhage, septic abortions, and puerperal sepsis [7]. Pre-existing conditions which may be aggravated by pregnancy are classified as non-obstetric causes. These classifications have elevated the significance of obstetric and intrapartum causes of maternal and child mortality to the detriment of non-obstetric or indirect causes [8]. Consequently, the contributions of healthcare professionals who do not provide direct obstetric healthcare to mothers and children has been undermined and excluded from the recognized maternal and child health workforce [9].

Pharmacists as health care professionals are readily accessible to women and children at any point during the continuum of care, for preventative advice and prescription filling though they do not provide direct obstetric services and are not recognized as part of the maternal and child health workforce [9]. Their traditional role as medicine custodians also saddles them with the responsibility to ensure that critical medication and sterile surgical products or devices required for contraception, vaccines, pregnancy, labour and delivery are readily available at hospitals and clinics [10]. The roles of pharmacists in maternal and child health care is outlined in the International Pharmaceutical Federation's statement of policy on the effective utilization of pharmacists in improving maternal, neonatal and child health across the continuum of care and in line with WHO suggested interventions to high-priority countries as it is currently experienced in practice [11]. Some of the services rendered which are also in line with the South African Pharmacy Council's Good Pharmacy Practice [12] recommendations include reproductive health care (provision of and education on various contraceptive options including emergency postcoital contraception). Pre-pregnancy care (folic acid) for women and adolescents [13], advising on the implications of pre-existing health conditions on pregnancy [14, 15], pregnancy tests, ensuring medication safety and managing simple pregnancy related conditions [13, 16] nutritional advice in pregnancy, and malaria prevention [17] are some of the other services. Baby and child health care (encouraging exclusive breastfeeding, immunization and adequate nutrition for infants and children) [18], and identifying women at risk of post-partum depression [15]. Health promotion and prevention (i.e. promoting a healthy planned pregnancy and preventing unintended pregnancies) is thus the core of pharmacists' service provision in maternal and child health care.

The South African Pharmacy Council regulates pharmacy education and practice in South Africa. The high rate of maternal and child mortality in the country warrants that all healthcare professionals who participate in maternal and child health care delivery are adequately trained to render quality and effective services that meet the needs of these group of patients. The South African Pharmacy Council's Good Pharmacy Practice manual stipulates the minimum professional standards required to provide maternal and child health care services in a pharmacy including standards for the physical facility and equipment [12]. Pharmacists are expected to know the procedures, interpretation, provision and explanation of results for each test carried out. Documentation, record keeping and confidentiality are stated as essentially parts of service provision. The need for adequate training that confers required knowledge and skills as crucial

for the provision of these services is highlighted. Registration of postgraduate training with the South African Pharmacy Council is mandated for the provision of reproductive health care services. A reason for the current Good Pharmacy Practice standards is in preparation for the pharmacist's role in the National Health Insurance (NHI) [12]. The NHI is the official South African policy to attain universal health coverage for all South Africans. It is posited on primary health care reengineering, which involves a change of focus from curative to health promotion and prevention [19], a role that pharmacists are trained to embrace.

Although pharmacists are in a position to positively influence pharmacotherapy and consequently the wellbeing of mothers and children, they often feel ill equipped to render such services. In an online cross-sectional, cross-country survey comparing the knowledge, perception and training opportunities of practicing and resident pharmacists in Canada, Qatar and Uganda, the overall knowledge in maternal and child health care was noted to be low at 53.7% [20]. A Nigerian study reported that although a high client load of mothers and children was established at community pharmacies, community pharmacists' baseline knowledge was inadequate to provide required services [21]. A Lithuanian study of 27 community pharmacists reported that they lacked adequate experience to advise pregnant women but they were more effective if the patient was an acquaintance [16]. Most community pharmacists alluded to the fact that their entry-level degree did not prepare them adequately for this speciality service [20]. In addition, lack of continuing professional development in maternal and child health care was mentioned as a hindrance to knowledge enhancement [20]. Indeed, access to resources for information varied among participants, resulting in different information being proffered for the same conditions [18]. Lack of knowledge about the safety and use of certain medications and absence of clinical data for herbal remedies during pregnancy hindered pharmacists from providing required counselling to patients [16].

In a study conducted at a Pakistan medical school, the reduction of high maternal and child mortality rate was hypothesized to be linked to undergraduate medical students maternal and child health care curriculum content exposure. Non-contextualized, inadequate and fragmented teaching methods were thought to be responsible for the knowledge and skills gap observed in medical graduates [22]. Similarly, in Zimbabwe, the neonatal mortality rate persisted at 29 per 1000 live births (1999 and 2015) despite a decrease (102 to 75) in under-five mortality rate in the same period. Further, an assessment of the state of healthcare facilities and quality of available service indicated significant knowledge and skills gaps among health workers in managing common new-born conditions [23].

Although several studies have evaluated the knowledge and skills of practicing pharmacists in maternal and child health care, no documented study has investigated undergraduate pharmacy students' knowledge and skills in this area or the adequacy of the undergraduate curriculum content to provide such knowledge and skills. This paper explores how undergraduate pharmacy education at a higher education institution in South Africa is preparing students to meet the maternal and child health care needs of the nation, one of the country's quadruple burdens of disease. The baseline study aimed to evaluate the knowledge and skills of 2017 final year pharmacy students who were exposed to a fragmented maternal and child health care curriculum at a university in South Africa to inform curriculum review.

Methods

Study design

The descriptive, quantitative, non-randomized study assessed final-year undergraduate pharmacy students' knowledge and skills in maternal and child health care, and their self-reported views on curriculum content exposure.

Setting

The University of the Western Cape hosts the only School of Pharmacy in the Western Cape province of South Africa. The School has four main academic disciplines, namely pharmaceutics, pharmacy practice, pharmaceutical chemistry and a combination of pharmacology and clinical pharmacy along with an experiential learning component. The curriculum is presented in modules per semester for each discipline. As such, a module topic would be covered asynchronously or non-systematically in the different disciplines over the four-year study period, thereby fragmenting student learning. In addition to the on campus theoretical and laboratory-based teaching, the school's experiential learning programme, Service Learning in Pharmacy (SLiP), aims to provide real world experiences for students to apply their theoretical knowledge [24]. An externship experience, also allows students to clock hours in pharmacies during their vacation periods. Also, some students opt to work as pharmacist's assistants after their second year of study to earn an income or gain experience, which is not a school requirement.

In 2013, the South African Pharmacy Council called for a curriculum change across pharmacy schools to redesign the curriculum towards clinical competencies required for patient centred pharmaceutical care [25]. In the pre-2013 curriculum, components of maternal and child health care such as contraception (with a contraception demonstration practical), pregnancy care, infant care, communicable diseases and immunization lectures were embedded in the discipline of pharmacy practice in

the third year of study. The post-2013 curriculum required all clinical components previously taught in the pharmacy practice discipline to move to the new discipline of pharmacology and clinical pharmacy (known as the discipline of pharmacology before 2013). Subsequently, the theoretical teaching of maternal and child health care moved between disciplines, from pharmacy practice (module PHA324) to pharmacology and clinical pharmacy (module PHC223). However, the reduced class time to cover all the maternal and child health care topics led to contraception remaining as a formal lecture while the rest of the topics were taught as a 2-h crash course (Table 1). Any other exposure to these topics may have been references to the importance of health education and medication safety in pregnancy and paediatrics during pharmacotherapy lectures. Maternal and child health care curriculum content exposure was concluded with more contraception lectures in the first semester of the 4th year of study.

The School took the new curriculum as an opportunity to embed relevance in its service learning programme and as such expanded it across all 4 years of study (previously only presented in the third and fourth years of study) [24]. SLiP was attached to pharmacology and clinical pharmacy modules in first, second and fourth year, and a pharmacy practice module in the third year, as it was intended to cut across disciplines to offer integrated, real world learning to the students. A dedicated service learning programme on maternal and child health care was developed for second year students in the second semester (attached to PHC223). This programme required student to perform maternal and child health care activities in public primary health care facilities under the supervision of facility nurses. Prior to this, the environmental health service learning programme in the second semester of the first year (attached to PHC123) focussed on diarrhoeal disease, one of the communicable diseases associated with neonatal and child mortality. This programme required students to prepare dry mixtures of oral rehydration salt and sugar prepacks under the supervision of South Africa Pharmacy Council registered faculty [25]. The dry formulation sachets prepared by the first-year students were distributed to the primary health care facilities by the second-year students who undertook their SLiP maternal and child health care programme in the same semester. At the facilities, second year students were expected to carry out health education activities that promote the health and wellness of mothers and infants, educate mothers on medicine administration (nevirapine, and vitamin A drops, oral rehydration solution (ORS) and deworming agents), participate in infant growth assessment, chart and interpret information in the infant road to health booklet under the direct guidance of a facility nurse.

Study participants

The target audience for the study were final year pharmacy students registered at the School of Pharmacy, University of the Western Cape in 2017. Out of the 102 registered students, five were recruited as student researchers leaving 97 students as possible study participants. The inclusion criterion was registration as a full final year student. Participants were excluded if they had outstanding modules to complete in either their third or second year of study.

Questionnaire development

A paper based structured questionnaire (see supplementary file for the questionnaire) which comprised of four main sections A, B, C and D was developed for the study thorough literature review of related published studies [11, 18, 20, 22]. Section A covered participants' demographic details which included age, gender, locum experience (a person who substitutes for another person from the same profession to temporarily fulfil their duties) and parenting status (if participants were parents). Section B (28 items) comprised of the knowledge section with three sub-sections: reproductive and sexual

Table 5.1 Maternal and child health curriculum content by year of study. Pre-2013 and 2013–2016 at the School of Pharmacy

Year of study	Pre-2013		2013–2016		
	3rd year	4th year	1st year	2nd year	4th year
MCH theoretical content	Contraception part 1 Pregnancy care, infant care, communicable diseases, immunization	Contraception part 2	Environmental and nutritional health (diarrhoeal disease, de-worming, Vitamin A supplementation, pregnancy supplements	Contraception part 1 Pregnancy and infant care, communicable diseases, immunization (2 h crash course)	Contraception part 2
Module code /discipline	PHA324/ Pharmacy practice	PHA414/ Pharmacy practice	PHC123/ Pharmacology and clinical pharmacy	PHC223/ Pharmacology and clinical pharmacy	PPR 414/ Pharmacy practice
SLiP activity /duration			ORS practical (in collaboration with Pharmaceutics discipline) /1 h Community visit/3 h	PHC Facility MCH-SLiP/ 9h	

Key: *SLiP* Service learning in pharmacy, *SLiP-MCH* Service learning in pharmacy-maternal and child health

health which focused on contraception (9 items, 9 marks); maternal and antenatal care which covered preconception and pregnancy care (10 items, 17 marks), and lastly, neonatal and child care, which included infant care and nutrition, childhood diseases and immunization (9 items and 12 marks). Section C (6 items, 8 marks) consisted of the skills section which assessed students' understanding of infant growth assessment procedures and its relevance. Sections B and C generated the scores for evaluation of participants' knowledge and skills with 34 items (46 marks) made up of multiple-choice (one mark per question) and short answer questions (one mark per response). Multiple-choice questions had the option of 'I don't know' to minimize guessing [20]. Section D assessed participants' maternal and child health care curriculum content exposure (curriculum assessment tool) over their undergraduate study period in order to contextualise their knowledge and skills evaluation outcomes.

Pilot study

A convenience sample of eight students participated in the pilot study. The pilot questionnaire was administered in the form of a closed book written test and which took place in a predetermined campus venue supervised by invigilators. Participants were required to answer all the questions and also assess the items in the questionnaire for validity, reliability, clarity and conciseness on a post-study questionnaire after the study questionnaire was completed and handed in to the invigilators. Questionnaire completion required about 45 min.

Analysis of the pilot study and post-study questionnaire revealed that of the eight students who participated in the pilot test, some found the questions clear and unambiguous (n = 5) while the others found some questions to be vague (n = 3). Participants' opinion was equally divided on whether there were too many questions or not. Most of the participants found the questions difficult and struggled to understand some abbreviations such as MUAC (mid-upper arm circumference) and terms like mastitis (n = 5). Generally, the participants agreed that the questions were basic; however, they struggled to answer some questions because they were not exposed or adequately exposed to certain maternal and child health care topics or they had forgotten some of the content. Participants suggested that the number of questions should be reduced, more immunization questions should be included and the skills assessment section should be omitted as in their opinion, it was not relevant to a pharmacist' scope of practice. They suggested that the instructions on the curriculum assessment tool (Section D) should be simplified. All the participants stated that the time given was sufficient to read the consent letter, complete the questionnaire and curriculum assessment tool. All of the participants found the information sheet and consent form easy to read and understand. The majority of the participants found a 50% pass mark in each knowledge subsection and skills section to be reasonable. A 50% score is the minimum pass mark for most modules at the university and it represents average lowest permissible knowledge of module content. A final questionnaire was prepared based on the comments from the pilot test participants, and additional comments and suggestions of four faculty members.

Validity and reliability

The content validity of the 34-item questionnaire was reviewed and verified by four faculty members who were knowledgeable in the subject area, five fourth year students recruited as researchers for this study and eight students who participated in the pilot study. They assessed the spread of the items, appropriateness, readability and clarity. However, a pilot study was carried out with one group of subjects to measure the questionnaire once and test its reliability. Although scoring agreement was not calculated but it was ensured by training the scorers on what do when grading the instruments, providing a moderated memorandum and ensuring that graded questionnaires were moderated. Unresolved discrepancies among scorers was fixed by the main author who authenticated all the graded questionnaires. In addition, to ensure reliability, questionnaire administration was carried out during a regular lecture time slot, timed and supervised appropriately. The content covered in the questionnaire was part of a university module and it served as a tool to assess the knowledge and skills acquired by participants from lectures. The medium of communication was English which is also the official language used at the university.

Recruitment and data collection

The final year students were informed of the research through verbal announcements during class periods and e-mails sent through the university's electronic communication platform. They were encouraged to participate in the study as the outcome would help to improve student learning in maternal and child health care at the School. Students were informed that their non-participation in the study would have no negative consequences towards their course assessment, as participation was completely voluntary. During a routine lecture period requiring the attendance of all final-year students at a designated venue, 54 of the available students excluding those who participated in the pilot study consented to participate in the study and they were provided with study information sheets and consent forms. Thereafter, the questionnaire was handed out and

self-administered. Participants were asked not to use the internet or consult with each other during the study which was timed for 60 min and supervised.

Data analysis

Three student researchers marked the completed questionnaires using a structured memorandum; thereafter two student researchers moderated the marked questionnaires before the marks were finalised and captured. Data was captured on an Excel spreadsheet and exported into the Statistical Package for the Social Sciences (SPSS) version 26 for analysis [26]. Data was analysed using participants' scores in the knowledge and skills sections descriptively as frequencies (n), percentages (%) and mean scores. Spearman's correlation (r) was conducted to explore the strength of the relationship between ranked continuous variables. Chi- square was used to compare the relationship between categorical variables (demographic characteristics and students pass (≥50%) and fail (< 50%) categories in reproductive and sexual health, maternal and antenatal care, and neonatal and child care). Student exposure to maternal and child health care curriculum content was determined descriptively in frequencies and percentages.

Results

On excluding the eight students who participated in the pilot study, 89 registered final year students were available for the main study. About 61% of them participated in the study. Two-thirds of the participants were female (63%) and 98% of participants' age ranged between 20 to 30 years. Eight (15%) participants were parents while over half (59%) did locums as post basic pharmacist's assistants. Six of those who did locum duties had more than 2 years' experience. Table 2 shows the demographic characteristics of participants.

Table 3 summarises the descriptive statistics for the participants' scores for each section of the questionnaire. Kolmogorov-Smirnov test of normality showed that the distribution of scores for the knowledge and skills sections was evenly split between normal (p =.025, p =.065) and non-normal distribution (p =.000) leading to the use of non-parametric tests for data analysis to avoid transforming variables for parametric tests. The mean scores were 62.4% in reproductive and sexual health, 54.5% in maternal and antenatal care, 50.4% in neonatal and child care and 25.3% in written assessment of participants' skills and understanding of the relevance of infant growth assessment.

Table 4 shows the number of participants who scored above or equal to 50% in each section of the questionnaire. The pass rate for the knowledge section was above 50% [reproductive and sexual health (78%), neonatal and child care (57%), maternal and antenatal care (56%)]

Table 5.2 Demographic characteristics of participants (*N*=54)

Demographic data	Number of participants *N*=54 (%)
Gender	
Female	34 (63)
Male	20 (37)
Age (in years)	
20 to 30	53 (98)
31 to 40	1 (2)
Parenting status	
Have children	8 (15)
No children	46 (85)
Locum	
Yes	32 (59)
No	22 (41)
Locum experience (in years)	
1 to 2	26 (48)
> 2	6 (11)

while the skills section recorded a pass rate of 19%. An overall average score of more than 50% was achieved by 44% of the participants. Excluding the scores for the skills section form the overall average score resulted in 65% pass rate. About 13% of participants scored above 50% in every section.

Table 5 indicates the number of participants who had the right responses per question. More participants gave the right responses to reproductive and sexual health questions (61%) while infant growth assessment skills recorded the least number of participants with the right responses (17%). Both maternal and antenatal care, and neonatal and child care had an equal number of participants with the right responses (44%).

In Fig. 1, a strong positive correlation (a corresponding increase) was observed in participants' knowledge of maternal and antenatal care, and neonatal and child care (r = 0.604); maternal and antenatal care, and reproductive and sexual health (r =0.604), neonatal and child care, and infant growth assessment skills (r = 0.511). Doing a locum, being a parent, gender or age had no significant effect on participants' knowledge and infant growth assessment skills (p > 0.05).

The result of participants self-reported curriculum content exposure is shown on Table 6. About 81% (n = 44) of the study participant completed the assessment tool. More participants (95%) reported on-campus exposure to reproductive and sexual health topics compared to maternal and antenatal (55%) and neonatal and child care (57%). During SLiP at the primary health care facilities, less participation occurred in neonatal and child care (67%) compared to infant growth assessment

Table 5.3 Descriptive analysis of participants scores in percentages (*N*=54)

	Reproductive and sexual health	Maternal and antenatal Care	Neonatal and child Care	Skills
Mean	62.4	54.5	50.4	25.3
Median	67	55	50	16
Mode	67	36	33	13
Std. Deviation	16	17.8	20.5	20
Minimum	22	27	0	0
Maximum	89	91	92	88
Percentiles 25	55	36	33	13
75	78	73	67	28.3
P-value	.000	.025	.062	.000

P-value=Kolmogorov-Smirnov test of normality.

activities (71%). Most participation (93%) was observed in maternal and antenatal where promotion of mother and infant health and well-being was carried out.

Discussion

The study assessed the knowledge and skills of final year pharmacy students in maternal and antenatal care against the backdrop of the high mortality rate recorded in sub-Saharan Africa and its occurrence as one of South Africa's quadruple burdens of disease. The country is optimising its health workers roles in maternal and child health care in order to achieve the targets of SDG 3 for 2030 through the reengineering of the primary health care system. Pharmacists as easily accessible health care providers especially in the community where 71% of graduates are employed and are an overlooked and underutilised resource in the fight to reduce maternal and child mortality rate [27]. Nevertheless, like with other health care professionals, adequate undergraduate and post qualification training are necessary to ensure competency in service provision. A few studies have assessed pharmacist's knowledge in maternal and child health care or its individual components. To our knowledge, no published study has assessed pharmacy students' knowledge and skills in maternal and child health although some work has been done on its individual components: reproductive and sexual health, maternal and antenatal care, and neonatal and child care [28–33].

Table 5.4 Number of participants who scored ≥ 50%

	Number of participants that scored ≥ 50% *N*=54 (%)
Reproductive and sexual health	42 (78)
Maternal and antenatal care	30 (56)
Neonatal and child care	31 (57)
Skills	10 (19)
In each knowledge subsection and skills section	7 (13)
Overall average score	24 (44)
Overall average score excluding skills section	35 (65)

Despite adequate notifications and information, about 61% of final year students consented to participate in the study. This may have been due to their busy schedule as final year students, or the fact that participation in the study did not contribute toward their academic grades, or apathy toward the research topic as not being very relevant to pharmacists. These opinions are shared in a guide for recruiting higher education students for research published by the Higher Education Quality Council of Ontario where student participation in research was indicated to be based on altruism, project related interest or self-centredness [34]. The self-centeredness of student participation may have been expressed in this study as more females (63%) aged between 20 to 30 years were interested in participating in the study probably in preparation for motherhood compared to males of the same age range. Alternatively, the higher female participation could be in line with the class gender distribution as observed in a demographic study of the final year class of 2015 [35]. Similarly, more female respondents were recorded in some studies of community pharmacist knowledge and service provision in maternal and child health care in the United States of America (USA), and a multi-country survey of Canada, Qatar and Uganda [20, 35]. The skewed interest in research participation does not indicate that females have better knowledge and skills in maternal and child health care as the current study found no association among knowledge scores and age, gender, parental or locum status. Similarly, a multi-country study of pharmacists offering maternal and child health care services showed that age, gender, parental status had no significant effect on participants' knowledge and skills. However, pregnant or lactating women were more comfortable to discuss their concerns with female than male pharmacists according to a Kuwait

Table 5.5 Number of participants with the right response per question

	N (54)	%	Median of the item
Reproductive and sexual health			61
1. Which hormones are present in combined oral contraceptives?	54	100	
2. When should combined oral contraceptives be started?	11	20	
3. Which contraceptive methods' effectiveness relies on the client's ability to use them correctly?	53	98	
4. Which contraceptives are Long acting reversible contraceptives (LARC)?	28	52	
5. When may the use of emergency contraception (EC) be indicated after sexual intercourse?	21	39	
6. Which information should the pharmacist obtain from the patient before emergency contraception is dispensed?	33	61	
7. Why is dual contraception encouraged?	10	19	
8. Which one of the following is true about oral progestogen-only pills?	51	94	
9. Rifampicin, Lopinavir/Ritonavir, Nevirapine are enzyme inducers that interact with oral contraceptives to do cause which effect?	40	74	
Maternal/antenatal care			44
1. All non-pregnant women of reproductive age should be advised to commence periconceptual folic acid supplementation (women planning pregnancy)	38	70	
2. What is the least number of antenatal clinic visits that every pregnant woman should attend?	18	33	
3. State 4 lifestyle modifications recommended for pregnant woman for a healthy pregnancy and baby?	48	89	
4. List 4 signs that a pregnancy is in danger	51	94	
5. When is antiretroviral (ARV) therapy initiated in newly diagnosed HIV positive pregnant women?	46	85	
6. Identify the non-teratogenic medicines on the list	8	15	
7. Which factors influence the manifestation and severity of teratogenicity?	27	50	
Explain the cause, pharmacological and non-pharmacological treatment of the following common conditions of pregnancy			
8. Morning sickness	24	44	
9. Heartburn[a]	11	20	
10. Vaginal thrush	24	44	
Neonatal and child care			44
1. Exclusive breastfeeding (EBF) is defined as giving only breast milk to infants for the first---------- months of life.	43	80	
2. An HIV exposed infant is one whose mother is HIV infected or whose HIV infection has not been confirmed or excluded. Which ARV medication is given to such infants at birth?	42	78	
3. WHO recommends that HIV positive women who are on ART should exclusively breastfeed their babies. True or false?	36	67	
4. What causes cracked nipples during breastfeeding?	9	17	
5. The Expanded Programme on Immunization (EPI) covers the major killer diseases of infanthood. List three of such diseases[b].	14	26	
6. How is diarrhoea treated in infants and children?	44	81	
7. Deworming agents are initially given to children at what age and at what interval subsequently?	24	44	
8. Outline one pharmacological and non-pharmacological treatment for diaper/nappy rash[a]	6	11	
9. How is mastitis treated?	11	20	
Skills assessment (Infant growth assessment)			17
1. Explain how an infant's (0–12 months) height is measured[a]?	4	7	
2. Should an infant be fully clothed or undressed during weight measurement?	49	91	
3. How is an infant's head circumference measured[a]?	1	2	
4. Why is an infant's head circumference measured?	17	31	
5. What is MUAC?	9	17	
6. Why is MUAC measured?	15	28	

MUAC Mid upper arm circumference. *HIV* Human immunodeficiency virus
[a] indicates the question counted for 2 marks and only participants who scored 2 marks are represented on the table
[b] indicates the question counted for three marks and only participants who scored 2 marks are represented on the table

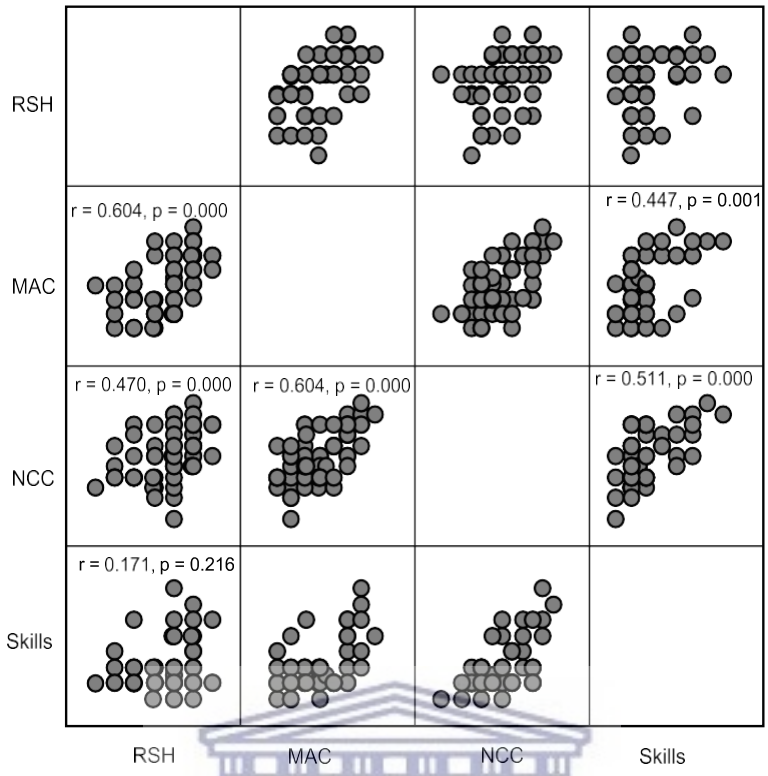

Fig. 5.1 Scatterplot matrix showing correlation among participants' ranked knowledge and skills mean scores. Statistically significant correlations were observed between maternal and antenatal care, and neonatal and child care (r=0.604, p =.000) reproductive and sexual health, and maternal and antenatal care (r=0.604, p =.000), neonatal and child care, and infant growth assessment skills (r=0.511 p =.000)

study of community pharmacists' rendering services to pregnancy and breastfeeding women [18].

Participants' knowledge of reproductive and sexual health

The reproductive and sexual health knowledge tested in this study focused mainly on contraceptive methods. The relevance of which is reflected in South African pharmacy practice as pharmacists are allowed to initiate and offer comprehensive reproductive health service after obtaining the necessary training and registering such supplementary training with the South African Pharmacy Council [12]. However, patients do not ask if pharmacists have supplementary training when consulting them for general reproductive and sexual health advice or information. As a result, undergraduate training should provide fundamental knowledge and skills in this area. Similarly, more than ten states in the USA have endorsed legislation permitting pharmacists to directly provide contraceptives to patients and studies assessing curriculum content and student knowledge are available [28, 29]. The impact of contraception on maternal and child mortality can be emphasized by a 2019 estimate from the Family Planning 2020 report for South Africa which estimated that if about 7.9 million women are on modern contraceptives, 2.9 million unintended pregnancies, 265,000 unsafe abortions and 2500 maternal deaths can be averted [36].

Assessment of the contraception knowledge and skills of participants in our study showed a mean score of 62.4% (median 67%), whereby over three-quarters.

(78%, n=42) of the participants had scored 50% and above. However, the high standard deviation (SD) of 16 shows that scores were widely spread out from the mean with an interquartile range (IQR) of 55–78%. Although the variation in reproductive and sexual health knowledge was wide amongst participants, 61% of the participants gave the right responses to the questions, and as such they may be relied on to render moderately adequate services to patients. This can be attributed to the comprehensive curriculum exposure as reported by 95% of the participants in the second and fourth year of study which included contraceptive products application demonstration session. Similarly, a pre-post intervention study carried out by El-ibiary et al. demonstrated that using multiple teaching methods for reproductive and

Table 5.6 Self-reported curriculum content exposure assessment (*N*=44)

Topic	Focus	N (44)	%	Median of the item
Reproductive and sexual health				95
	Contraceptive methods available in South Africa	44	100	
	How the methods work	43	98	
	Efficacy, when effective, duration of use	41	93	
	Advantages and disadvantages	42	95	
	Potential short term and long-term effects	40	91	
	Special precautions	41	93	
	Possible problems to report	41	93	
	Return to fertility	43	98	
	Post coital contraception	42	95	
Maternal and antenatal care				55
	Folic acid & Fe Supplement for pre-pregnancy	28	64	
	HIV therapy provision pre-pregnant	31	70	
	Lifestyle modifications for pregnant women	25	57	
	Deworming agents during pregnancy	13	30	
	Tetanus immunization protocols during pregnancy	13	30	
	Treatment of infection (UTI, STI, etc.)	32	73	
	Importance of antenatal visits	21	48	
	HIV treatment during pregnancy	39	89	
	Choices for unwanted pregnancy (abortion, adoption)	22	50	
	Maternal danger signs in pregnancy	22	50	
	Medicines contraindicated in pregnancy	30	68	
	Common conditions in pregnancy, management/treatment	19	43	
	Role of pharmacists in pregnancy care	24	55	
	Postpartum depression	10	23	
	Suitable contraceptive methods	34	77	
	Medicines contraindicated in lactating mothers	30	68	
	Management of common breastfeeding conditions	18	41	
Neonatal and child care				57
	Exclusive & complementary breastfeeding	39	89	
	Breast milk substitutes complementary feeding options	19	43	
	Children immunisation protocols	25	57	
	Infant and children vitamin supplementation	25	57	
	Treatment of infections in children (HIV, pneumonia, etc.)	29	66	
	Treatment of diarrhoea in children	37	84	
	Improving of drinking water	28	64	
	Deworming	20	45	
	Medicines contraindicated in infants	20	45	
	Common infant problems, management/treatment	15	34	
	Role of pharmacists in infant care	18	41	
Service learning in pharmacy (SLIP)				
Maternal and antenatal care	Exclusive breastfeeding	38	86	93
	Lifestyle and nutrition	36	82	
	Safe sex practice	41	93	

Table 3.6 Self-reported curriculum content exposure assessment (*N*=44) *(Continued)*

Topic	Focus	N (44)	%	Median of the item
	Contraceptive use	43	98	
	Handwashing, personal hygiene	41	93	
Neonatal and child care	Nevirapine administration to infants	31	70	64
	Oral rehydrate solution	40	91	
	Vitamin A supplementation	23	52	
	De-worming agent	21	48	
	Immunisation protocol	28	64	
	Assess infant's dehydration status	31	70	
	Advice when infant vomits therapy	17	39	
Infant growth assessment	Infant weight, height taken	33	75	71
	Interpret/ evaluate growth	29	66	

UTI Urinary tract infection. *STI* Sexually transmitted infection

sexual health improved students' knowledge and confidence [28]. In addition, some studies have shown that a dispersed teaching approach, like the one used in this curriculum, by spreading the content for contraceptives between second and fourth year, enhanced long-term knowledge retention [37, 38].

Participants' knowledge of maternal and antenatal care

Maternal and antenatal care included preconception care in this study. The South African Maternal Care Guidelines (2015) encourages all health workers who care for women of reproductive age to offer preconception care [39]. The guideline also explains that antenatal care aims to ensure that women have a safe pregnancy and healthy babies. Pharmacists and pharmacy students need to have adequate knowledge and skills as they often offer care and advice to women of reproductive age and pregnant women at different health care settings. Participants' mean and median scores for maternal and antenatal care was 54.5%, slightly above the minimum allowed pass mark of 50% with 56% (n = 30) of the participants scoring 50% and above. Participants' scores were widely dispersed from the mean (SD 17.8) and showed a slightly above average knowledge of maternal and antenatal care content which was less than reproductive and sexual health content. The unexceptional knowledge observed for study participants may be attributed to the 2-h single exposure to relevant curriculum content in the second year of study which was brief, and occurred 2 years prior to the study commencement. The effect of teaching methods on long term knowledge retention may have resulted in about 47% of the participant being able to give the right answers to the questions in our study. This was further highlighted in a study of 133 third year pharmacy students enrolled in a 6 years Doctor of Pharmacy programme at a private, midwestern university [30]. Participants' knowledge of folic acid and neural tube defects based on the online education was assessed using pre-post intervention longitudinal survey. At baseline, 50% of the participants could correctly answer 5 out of the 10 questions. The intervention was a 30 min video followed immediately with a post-test which showed statistically significant improvements in the response of the participants to nine of the 10 questions. However, a longitudinal test carried out 9 months after the post-test indicated a drop-in participants' performance relative to the post-test but an increase compared to baseline knowledge with statistically significant increases in six of the nine questions relative to baseline. The result demonstrated the inadequacy of the online, one-time exposure for long term knowledge retention [30]. Curriculum content exposure assessment in the present study showed that about 55% of participants acknowledged receiving lectures on maternal and antenatal care. However, this contradicts the SLiP experience where 93% participation was recorded in health and wellness promotion for maternal and antenatal care. The interaction could have enhanced participants' performance as alluded to by Bheekie et al. in their study of the opportunities for student learning and service delivery in SLiP where they explained that it enabled contextualized learning [24]. A study evaluating the University of Arizona College of Pharmacy's curriculum and the knowledge and abilities of pharmacy students to counsel pregnant and breastfeeding women about the use of over-the-counter products and prescription medications revealed that the curriculum was deficient in some areas such as teratogenicity and comprehensive case studies. The lack of knowledge and abilities was reinforced by Arizona College of Pharmacy study participants' indication of their inadequacy to render services to this patient population regardless of their year of study [31].

Participants' knowledge of neonatal and child care

The ability of pharmacists to recognise the symptoms of common childhood illnesses like diarrhoea and the importance of early referral would contribute immensely to the reduction of infant and child mortality. Knowledge of relevant, age specific nutrition and immunization protocol would be invaluable to service provision. Participants in the current study had a mean score of 50.4% in neonatal and child care. About 57% (n = 31) scored above 50% with wider dispersion from the mean (SD 20.6) compared to reproductive and sexual health, and maternal and antenatal care. Neonatal and child care had the highest maximum score of 92% but a minimum score of 0% which supports the high score dispersion observed (IQR 33–67%). Participants' close performance in neonatal and child care (50.4%) and maternal and antenatal care (54.5%) may be attributed to the two topics being taught during the 2-h single exposure in the second year of study. This is further supported with the observation that almost the same number of participants gave the right answers to neonatal and child care and maternal and antenatal care questions respectively (44, 47%). In addition, the similarity in participants' performance was also statistically supported as significant because an increase in participants knowledge of neonatal and child care was shown to be positively correlated to same in maternal and antenatal care ($r = 0.604$, $p < 0.005$). However, the slight difference between the mean score for neonatal and child care (50.4%) and maternal and antenatal care (54.5%) may be attributed to higher student participation in maternal and antenatal care (93%) observed during SLiP which may have helped to contextualize student learning and aid knowledge retention. Similarly, a study involving final year students in all pharmacy programmes in Jordan showed that 62.1% of the 354 participants scored two or less out of five in the realistic case scenarios used to assess knowledge of paediatric treatment and dosing with 81.1% of the participants indicating that more paediatric related topics should be included in the curriculum. About 44% of participants self-reported competency in paediatrics for future practice. Absence of adequate hands on practical training was also insinuated to have contributed to the deficiency in participants knowledge [32]. The importance of paediatric training in USA Colleges and Schools of Pharmacy is emphasized by the recommendation made by the Paediatric Practice and Research Network (PRN) of the American College of Clinical Pharmacy in 2005. PRN's recommendation included a minimum of 25 h of classroom instruction in paediatrics from the first year of the PharmD programme, an elective course consisting of 16 to 32 contact hours, and at least 1 practice experience in paediatrics. Pharmacists in the USA can be certified as immunizers in addition to providing information about immunizations as one of their expanded roles [33]. Similarly, South African pharmacists can be certified as immunizers with the appropriate training but the establishment of baby wellness clinics run by nurses in most retail chain pharmacies discourages most pharmacists from acquiring this skill [12, 40].

Infant and young child feeding is a major part of neonatal and child care and exclusive breastfeeding (EBF) has been shown to have global advantages to mothers, babies and the community. The global risk of death to exclusively breastfed infants has been estimated to be 12% less compared to that of non-breastfed infants and 13.8% of deaths of children below 2 years can be averted by EBF [41]. Universally, EBF has been shown to prevent 20,000 breast cancer deaths in mothers annually [42]. Sadly, about 32% of South African babies were exclusively breastfed in 2016 despite the 2012 policy which expects all health workers to promote EBF for 6 months irrespective of the human immunodeficiency virus (HIV) status of the mother. Interestingly, about 80% of participants in our study understood how long a baby should be exclusively breastfed. However, Edwards reported in his study that there were a few available studies on pharmacists' education and knowledge regarding breastfeeding. While most of them focused on medication and lactation, they lacked information on infant feeding guidelines [43]. To address the gap, he created and piloted an online breastfeeding tutorial for pharmacy students at three schools of pharmacy in the USA. A survey of students' attitudes regarding their roles in infant feeding on completion of the online tutorial revealed that 78% of participants recognised the importance of their role in providing advice about meeting the nutritional needs of infants and supporting parent's infant feeding choices (86%). A few participants lacked or had little confidence that they could answer questions from parents on breastfeeding their infants (14%) and the introduction of solid foods to their infants (24%).

Participants' infant growth assessment skills' knowledge

Participants in our study showed poor ability to assess infant growth with a mean score of 25.3%, well below the minimum permissible pass mark of 50% with 19% (n = 10) scoring 50% and above. About 17% of the participants gave the right answers to the questions in this section. Participants' poor knowledge of infant growth assessment processes and its relevance may have been affected by the lack of on-campus practical exposure. However, despite the lack of on-campus practical exposure, 71% of the participants self-reported carrying out this assessment at the primary health care facilities during the second year SLiP programme which should have imparted some knowledge and skills to them at the time.

This assumption is supported by the correlation observed between participants knowledge of neonatal and child care and infant growth assessment skills in our study result ($r = 0.511$ $p < 0.005$), that an increase in one would lead to an increase in the other. A plausible reason for the large difference between participants mean scores may be assumed to be as a result of inadequate curriculum exposure and knowledge decay over time. A prospective study of fourth year medical students' knowledge retention with regard to communication with patients and the physical examination after an introductory course in basic paediatric cardiology at a university in Brazil showed knowledge decay over time. Students' knowledge of the basis of clinical skills, diseases and pathophysiology mechanisms was found to decrease progressively from the initial score obtained immediately after the lecture, 6 months and a year later. Knowledge decay was said to occur due to lack of use [44].

Participants in our pilot test had advised that the skills section be excluded from the questionnaire as it was not relevant to pharmacists. However, since 2016, the South African Pharmacy Council recommended that second year pharmacy students should have hands-on training at primary health care facilities during the SLiP maternal and child health care programme to enhance skill development in child care. The purpose of infant growth assessment skills is to determine whether a child has a growth problem (i.e. over or underweight), which sometimes points to a nutrition-based origin that should be addressed as early as possible to prevent lasting health complications [45]. The ability of pharmacists to provide practical and measurement-based proof validates the information provided to the patient. In addition, the South African Pharmacy Council's Good Pharmacy Practice requires pharmacists providing baby and child health care to be informed about childhood problems and the importance of early referral [12].

Overall, about seven (13%) out of the 54 participants passed all the sections of the assessment by scoring 50% and above in the knowledge and skills sections. This is a poor reflection of participants' knowledge and skills in maternal and child health care. When scores from the different sections were added together, 24 (44%) of participants had an average score of 50%. Although the 'pass mark' was set at 50% in this study, a study that compared pharmacist knowledge, perceptions and training opportunities regarding maternal-foetal medicine in Canada, Qatar and Uganda recorded knowledge assessment mean scores of 62.9, 53.3, and 57.7% respectively for each country ($p < 0.05$). The scores were interpreted as low, alluding to it being responsible for the creation of a knowledge gap in practice [20]. Similarly, a Pakistan study where maternal and child health care content was integrated in a medical curriculum showed that assessment mean scores of above 78% indicated that participants had acquired adequate knowledge and skills [22].

Motivation for curriculum review and integration

This study reported on a maternal and child health care curriculum content that although it incorporated different types of learning activities (on campus theoretical and experiential) was largely not integrated. Indeed, traditional, discipline-based methods of teaching are usually done in silos and compartmentalises learning, thereby depriving the student of the opportunity to integrate curriculum content and acquire a holistic education that is applicable to real life situations. A nine-year study on the impact of changing from traditional to integrated problem-based learning at a school of pharmacy in South Africa showed that student pass rate increased after curriculum integration [46]. Zaman and Rauf explained the argument of medical educationalists that most health issues were transdisciplinary and countered the disciplinary approach used in most medical schools. They pointed out that if the curriculum was integrated students would be more likely to develop a preventive as opposed to a curative care mentality [22]. Indeed, focus should be on improving a preventative mentality in maternal and child health care as much as the obstetric causes [3].

Although no study of community pharmacists' maternal and child health care knowledge, skills and attitude has been done in South Africa, some studies from around the world indicate a gap and recommend undergraduate curriculum review, continuing professional development courses for practicing pharmacists and access to maternal and child health care resources [18, 20, 47]. The call for undergraduate curriculum review indicates a deficiency in maternal and child health care curriculum content and lack of programme integration which may be attributed to pharmacy educators': (1) lack of knowledge of the role of pharmacists in maternal and child health care, (2) lack of knowledge of the policy and guidelines that support service delivery, (3) lack of knowledge of local need for such services, and (4) non-involvement in solving the problem where one exists [22]. In South Africa, the issue is further complicated by the proliferation of big chain pharmacies that limit patient consultation time [48] and the attendant practice of nurse-pharmacist partnerships where nurses attend to all maternal and child health care issues within pharmacies like in the public sector. This practice confirms to pharmacy graduates and undergraduates alike the absence of a role for them in maternal and child health care [49]. This is contrary to global trends in developed countries where pharmacists are extending their roles in primary health care and practicing at the top of their licenced capabilities [13–15]. Social accountability and

needs based education proponents recommend that undergraduate education must meet the needs of the population to be served [50]. This can only be achieved through properly designed and integrated curriculum content, skills practical and experiential learning programmes for pharmacy undergraduates in maternal and child health care like that of their medical counterparts [22].

Limitations

The outcome of this study may not be generalisable since it was carried out at one pharmacy school in South Africa with a single cohort of participants. Additionally, it was difficult to find studies to compare these results with, because most knowledge studies would focus on specific aspects of either reproductive and sexual health, maternal and antenatal care, or neonatal and child care and not on all aspects. This reinforces the fragmented approach to maternal and child health care training which opposes the concept of a continuum of care.

The sample population for this study posed a limitation as students were generally unwilling to participate in assessments that did not contribute toward their academic grades, and one that would analyse and disseminate their scores even if anonymized. Since convenience sampling and not randomised or purposive sampling methods was used, with about 61% of the class partici- pating in the study, the result may not be a true reflec- tion of the class performance. Written evaluation of infant growth assessment skills rather than traditional objective structured clinical examination or practical evaluation due to lack of adequate man power may have compromised the result of that section.

Conclusion

The study identified a knowledge and skills gap in maternal and child health care amongst fourth year pharmacy students especially in the skills acquisition to assess infant growth. Better outcomes were observed in maternal and antenatal care and neonatal and child care with the best outcome in reproductive and sexual health. This was thought to be due to the inadequacy of curriculum content exposure and fragmented teaching methods that participants were exposed to for maternal and child health care related topics. Based on the result of this study, it is recommended that maternal and antenatal care, and neonatal and child care topics should be allocated adequate lecture time slots and an on-campus infant skills assessment practical be introduced before the SLiP programme. All the components of maternal and child health care should be integrated to ensure optimal student learning and to produce pharmacy graduates that are fit for service.

Supplementary Information

The online version contains supplementary material available at https://Doi.org/10.1186/s12909-020-02476-9.

Additional file 1. Questionnaire used for data collection in the study

Abbreviations

EBF: Exclusive breastfeeding; HIV: Human immunodeficiency virus; IQR: Interquartile range; MAC: Maternal and antenatal care; MCH: Maternal and child health; MUAC: Mid upper arm circumference; NCC: Neonatal and child care; NHI: National Health Insurance; ORS: Oral rehydration solution; PHC: Primary health care; PRN: Practice and Research Network; RSH: Reproductive and sexual health; SD: Standard deviation; SDG: Sustainable development goals; SLiP: Service learning in pharmacy; USA: United States of America; WHO: World Health Organization

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Authors' contributions

EE participated in all steps from conception to writing of manuscript; RC participated in manuscript revision; MvH and AB participated in the conception, design and critical revision of manuscript. All the authors read and approved the final version.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Ethics approval was obtained from the Humanities and Social Sciences Research Ethics Committee (registration number HS/17/5/12) and the Registrar's office, University of the Western Cape. A consent form was signed by each participant before completing the questionnaire. Participants were informed that participation is voluntary and they could exit the study at any time. Throughout the study, participants were identified by unique numbers instead of their names to protect their privacy. None of the completed study materials which were kept by the main researcher contained the names of the participants. Study materials were not accessed by other persons outside the researcher team to ensure confidentiality.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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References

1. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. Lancet. 2007;370(9595):1358–69.
2. Bellizzi S, Mannava P, Nagai M, Sobel HL. Reasons for discontinuation of contraception among women with a current unintended pregnancy in 36 low and middle-income. Contraception. 2020;101:26–33.
3. World Health Organization. Health in 2015: from MDGs, Millennium Development Goals to SDGs, Sustainable Development Goals: World Health

Organisation; 2015. Available from: http://who.int/gho/publications/mdgs-sdgs/en/.
4. United Nations Report. More women and children survive today than ever before – UN report: who.int; 2019. [cited 2020 Mar 17]. Available from: https://www.who.int/news-room/detail/19-09-2019-more-women-and-children-survive-today-than-ever-before-un-report.
5. STATS SA. Sustainable Development Goals: Country report 2019. South Africa: Statistics South Africa; 2019. [cited 2020 Mar 17]. Available from: www.statssa.gov.za.
6. WHO. The WHO application of ICD-10 to deaths during the perinatal period: ICD-PM: World Heal Organ; 2016. p. 1–88.
7. WHO. The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM, vol. 129: WHO Library; 2012. Available from: http://apps.who.int/iris/bitstream/10665/70929/1/9789241548458_eng.pdf.
8. van den Akker T, Nair M, Goedhart M, Schutte J, Schaap T. Knight M. Maternal mortality: direct or indirect has become irrelevant. Lancet Glob Health. 2017;5:e1181–2.
9. World Health Organization. Optimizing health worker roles to improve access to key maternal and newborn health interventions through task shifting: World Health Organisation; 2012. Available from: www.who.int/reproductivehealth%0A. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:health+worker+roles+to+improve+access+to+key+maternal+and+newborn+health+interventions+through+task+shifting#0%5Cn. http://scholar.google.com/scholar?hl=en&btnG=S.
10. Ferrand E, Painchart L, Grimandi G, Décaudin B, Bussières JF. The roles and the impacts of pharmacists in the management of medical devices at the hospital: A literature review. Ann Pharm Fr. 2017;75:409–19 [cited 2020 Mar 17]Available from: http://www.ncbi.nlm.nih.gov/pubmed/28666516.
11. International Pharmaceutical Federation (FIP). FIP statement of policy on the effective utilization of pharmacists in improving maternal, newborn and child health (MNCH). Dublin; 2013.
12. SAPC. Good Pharmacy Practice Manual and Associated SAPC rules GOOD PHARMACY PRACTICE IN SOUTH AFRICA: South African Pharmacy Council; 2017. p. 194. Available from: http://www.pharmcouncil.co.za/G_PublicationsD.asp.
13. Mospan CM. Pharmacists as women's health providers: Increasing access to contraception and preconception care. J Am Pharm Assoc. 2019;59:613–4.
14. Brown S, Henderson E, Sullivan C. The feasibility and acceptability of the provision of alcohol screening and brief advice in pharmacies for women accessing emergency contraception: an evaluation study. BMC Public Health. 2014;14:1139.
15. Ragland D, Payakachat N, Hays EB, Banken J, Dajani NK, Ott RE. Depression and diabetes: establishing the pharmacist's role in detecting comorbidity in pregnant women. J Am Pharm Assoc. 2010;50(2):195–9.
16. Grincevičienė Š, Kubilienė L, Ivanauskas K, Drąsutienė GS, RamaŠauskaitė D, Grincevičius J, et al. Experiences of community pharmacists advising pregnant women. Int J Clin Pharm. 2015;37(4):636–44.
17. Mangham-Jefferies L, Hanson K, Mbacham W, Onwujekwe O, Wiseman V. Mind the gap: Knowledge and practice of providers treating uncomplicated malaria at public and mission health facilities, pharmacies and drug stores in Cameroon and Nigeria. Health Policy Plan. 2015;30(9):1129–41 [cited 2020 Mar 18];Available from: https://academic.oup.com/heapol/article/30/9/1129/662506.
18. Albassam A, Awad A. Community pharmacists' services for women during pregnancy and breast feeding in Kuwait: a cross-sectional study. BMJ Open. 2018;8(1):1–8.
19. Kumar R. Provincial guidelines for the implementation of the three streams of PHC re-engineering. , provincial guidelines, vol. 3; 2011. p. 1–10.
20. Bains S, Kitutu FE, Rahhal A, Abu Samaha R, Wilby KJ, Rowe H. Comparison of pharmacist knowledge, perceptions and training opportunities regarding maternal-fetal medicine in Canada, Qatar and Uganda. Can Pharm J (Ott). 2014;147(6):345–51 [cited 2018 Nov 13]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25364351.
21. Faduyile 'T, Oparah AC. Potentials of Community Pharmacists to Improve Maternal, Newborn and Child Health. West Afr J Pharm. 2012;23(2):27–33.
22. Zaman IF, Rauf A. Working toward decreasing infant mortality in developing countries through change in the medical curriculum. Asia Pac Fam Med. 2011;10(1):1–9.
23. Chimhuya S, Mbuwayesango B, Aagaard EM, Nathoo KJ. Development of a neonatal curriculum for medical students in Zimbabwe - a cross sectional survey. BMC Med Educ. 2018;18(1):1–9.
24. Bheekie A, Obikeze K, Bapoo R, Ebrahim N. Service learning in pharmacy: opportunities for student learning and service delivery. Afr J Pharm Pharmacol. 2011;5(23):2546–57.
25. Mvan H, Bheekie A. Embedding relevance in pharmacy training: a case study from South Africa. Pharm Educ. 2015;15(1):270–4 [cited 2018 Nov 7]. Available from: http://pharmacyeducation.fip.org/pharmacyeducation/article/view/419.
26. IBM. IBM SPSS Statistics for Windows 2019 version 26. 2019.
27. Van Huyssteen M, Bheekie A. The hidden curriculum of work-based learning for pharmacy students in public sector pharmacies in South Africa. Pharm Educ. 2017;17(1):190–8.
28. El-Ibiary SY, Azizoddin A, Petrossian L, Gurney MK. Implementation and evaluation of a women's reproductive health pharmacy elective. Curr Pharm Teach Learn. 2018;10(8):1087–96. Available from. https://Doi.org/10.1016/j.cptl.2018.05.007.
29. Rim C, El-Ibiary SY, Rafie S, Borgelt LM. Assessment of contraceptive curricula in US pharmacy programs. Curr Pharm Teach Learn. 2020;12(4):395–9.
30. Bykhovsky M, Meier MFK, Mager NAD. Impact of an online educational program on pharmacy students knowledge of folic acid and neural tube defects. J Pharm Pract. 2014;27(5):513–7 Available from: http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=98674075&site=ehost-live.
31. Grimm R, Knickerbocker-Manns A, Saldamando D. Evaluation of the University of Arizona College of Pharmacy's curriculum and pharmacy students' knowledge and abilities to counsel women about the use of over-the-counter products and prescription medications during pregnancy and breastfeeding; 2009.
32. Mukattash TL, Jarab AS, Abu-farha RK, Alefishat E, Mcelnay JC. Pharmaceutical Care in Children. 2018;18(November):468–75.
33. Kubli K, McBane S, Hirsch JD, Lorentz S. Student pharmacists' perceptions of immunizations. Curr Pharm Teach Learn [Internet]. 2017;9(3):479–85 Available from: http://www.sciencedirect.com/science/article/pii/S1877129716300430.
34. Cyr D, Childs R, Elgie S. Recruiting Students for Research in Postsecondary Education : A Guide Darren Cyr , Ruth Childs and Susan Elgie; 2016.
35. Lio I, Remines J, Nadpara PA, Kelly"R GJ-V. Pharmacists' comfort level and knowledge about prescribing hormonal contraception in a supermarket chain pharmacy. J Am Pharm Assoc. 2018;58(4):S89–93 [cited 2020 Mar 17]. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1544319118302255.
36. FP2020. South Africa: FP2020 Core Indicator Summary Sheet: 2018–2019 Annual Progress Report [Internet]. FP2020 Women at the Center 2018–2019. 2019. Available from: http://sk.sagepub.com/reference/cancer/n572.xml.
37. Raman M, McLaughlin K, Violato C, Rostom A, Allard JP, Coderre S. Teaching in small portions dispersed over time enhances long-term knowledge retention. Med Teach. 2010;32(3):250–5.
38. Mcbride JM, Drake RL. Longitudinal cohort study on medical student retention of anatomical knowledge in an integrated problem-based learning curriculum; 2016.
39. Department of Health SA. Guidelines for Maternity Care in South Africa. Department of Health, S. A. (2007). Guidelines for Maternity Care in South Africa 2007 : A manual for clinics, community health centres and district hospitals, 1–173.007 : A manual for clinics, community heal. 2015.
40. Gilbert L. Pharmacist and nurse: a team approach towards primary health care or a convenient "therapeutic alliance"? Int J Nurs Stud. 1997;34(5):367–74.
41. Nieuwoudt SJ, Ngandu CB, Manderson L, Norris SA. Exclusive breastfeeding policy, practice and influences in South Africa, 1980 to 2018: A mixed-methods systematic review. PLoS One. 2019;14(10):e0224029. [cited 2020 Jun 1]Available from. https://Doi.org/10.1371/journal.pone.0224029.
42. du Plessis L, Peer N, Honikman S, English R. Breastfeeding in South Africa: are we making progress? Sahr. 2016:109–23.
43. Edwards RA. Expanding pharmacists' roles in breastfeeding support: a pilot study of an online breastfeeding tutorial for student pharmacists. Curr Pharm Teach Learn. 2013;5(2):129–33 Available from: http://www.sciencedirect.com/science/article/pii/S1877129712000901.
44. Amaral F. Retention of knowledge and clinical skills by medical students: a pro-spective, longitudinal, one-year study using basic pediatric cardiology as a model. Open Med Educ J. 2013;6(1):48–54.
45. World Health Organization. Training Course on Child Growth Assessment WHO Child Growth Standards: Interpreting Growth Indicators, vol. 7: World Health Organization; 2008.

46. Mabope LA, Meyer JC. A problem-based learning BPharm curriculum at a previously disadvantaged university in South Africa. 2014;6(2):133–137.
47. Alrabiah Z, Al-Arifi MN, Alghadeer M, Wajid S, Alqahtani A, Almotari N, et al. Knowledge of community pharmacists about the risks of medication use during pregnancy in central region of Saudi Arabia. Saudi Pharm J. 2017;25: 1093–6. [cited 2019 Feb 1]Available from. https://Doi.org/10.1016/j.jsps.2017.05.005.
48. Adams E. Independent community pharmacy: Quo vadis? Bus Sch. 2011; Masters (M (March):91. Available from: http://hdl.handle.net/10019.1/14640.
49. Gilbert L. To diagnose, prescribe and dispense: whose right is it? The ongoing struggle between pharmacy and medicine in South Africa. Curr Sociol. 2001;49(3):97–118. Available from:. https://Doi.org/10.1177/0011392101049003007.
50. Bheekie A, Van Huyssteen M, Coetzee R. Exploring the Implications of a Needs-Based Pharmacy Education Framework Modelled on Population Health: Perspective from a Developing Country. Pharmacy. 2019;7(3):–116 [cited 2020 Feb 22] Available from: https://www.mdpi.com/2226-4787/7/3/116.

Publisher's Note

CHAPTER SIX: Development and implementation of an integrated framework for undergraduate pharmacy training in maternal and child health at a South African university

In this chapter, a research paper entitled:

"Development and Implementation of an Integrated Framework for Undergraduate Pharmacy Training in Maternal and Child Health at a South African University", is presented. It was published as a research article in MDPI Pharmacy, 2021, 9,163. https://Doi.org/10.3390/ pharmacy9040163. It has been used in this thesis as an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

The research paper presented in this chapter reports on the second phase of the research project which involved cohorts 1 and 4 (the same cohort of students that participated in the research project in the second and final years of study, 2017 and 2019). The results obtained from the first phase indicated a need for an intervention to enhance fill the MCH knowledge and skills gap observed in undergraduate pharmacy students. Based on global reforms in pharmacy education, the intervention entailed a change from the traditional, fragmented curriculum to an integrated MCH framework that is contextual, applied, nestled, connected, dispersed longitudinally and incorporates active teaching methods to motivate students and enhance learning, knowledge and skills retention, and application. The questionnaire used in the first phase of the research project was used to assess students' performance in the current study pre, post and two years after the intervention. The results showed that participants' knowledge and skills increased post-intervention but decreased significantly two years later except in the reproductive and sexual health section (contraception) where participants experienced longitudinal integration of the MCH component. Generally, participants performed above the university average except in maternal and antenatal care.

pharmacy

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Article

Development and Implementation of an Integrated Framework for Undergraduate Pharmacy Training in Maternal and Child Health at a South African University

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Abstract: The South African Pharmacy Council (SAPC) regulates undergraduate pharmacy education and pharmacy practice. The SAPC Good Pharmacy Practice manual describes the role of pharmacists in maternal and child health (MCH) in line with the recommendation of international health regulatory bodies. However, baseline study findings in 2017 supported literature from around the world that indicated a need for curriculum review and integration to address the knowledge and skills gap in pharmacists' MCH training. This paper describes the development and implementation of an integrated framework for MCH training across the four years of a Bachelor of Pharmacy program. The intervention included didactic lectures, skills practical on infant growth assessment, and an experiential learning component at primary health care clinics and pharmacies. Knowledge and skills assessment on contraception, maternal and antenatal care, and neonatal and child care were carried out pre, eight weeks post, and two years post intervention using the same questionnaire. ANOVA and post hoc analyses showed that participants' knowledge and skills increased post intervention but decreased significantly two years later except in contraception where students experienced longitudinal integration of the MCH component. Generally, participants performed above the university average except in maternal and antenatal care.

Keywords: curriculum; integrated maternal and child health care framework; undergraduate pharmacy students; knowledge; skills and attitude; pharmacy education; South Africa

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1. Introduction

The delivery of maternal and child health (MCH) services in South Africa is undertaken at the primary health care (PHC) level [1]. As one of the quadruple burdens of disease in the country, the high maternal (121 per 100,000 in 2015) and under-five mortality (42 per 1000 live births in 2016) ratios require that all health care professionals who participate in MCH care delivery are effectively trained to deliver the required health care services to this group of patients [2,3]. The high rate of unplanned and teenage pregnancies further contributes to maternal and child mortality upsurges from unsafe abortions and the increased risk of complications for both mothers and babies [4]. The high mortality ratio is attributed to a lack of access to skilled health care professionals and quality health care services [5].

Pharmacists' roles as providers of indirect obstetric care in MCH are documented in the International Pharmaceutical Federation's (FIP) statement of policy on the effective utilization of pharmacists in improving maternal, neonatal, and child health [3,6]. The delivery of care cuts across the continuum of MCH care and is in line with World Health Organization's (WHO) suggested interventions to low- and middle-income countries with high burdens of mortality [7].

The regulation of undergraduate pharmacy education (Bachelor of Pharmacy) and practice in South Africa is overseen by the South African Pharmacy Council (SAPC) [8].

The SAPC has competency standards to guide undergraduate education and training in line with the FIP global competency framework (2012), which are relevant to MCH at the PHC level (Table 1) [9]. The minimum professional standards required to provide MCH services at the PHC level usually offered in community pharmacies are prescribed in the SAPC's Good Pharmacy Practice manual [8]. The manual emphasizes the need for adequate training, knowledge, and skills. The importance of understanding the physical facility, equipment, procedures, documentation, record keeping, and confidentiality necessary to render these services is also highlighted. The MCH services that may be rendered by pharmacists include immunization, pregnancy tests, nutrition in pregnancy, baby and child health care, and reproductive health services. Pharmacist can offer comprehensive reproductive health services if the necessary postgraduate training has been obtained and registered with the SAPC. However, pharmacists are allowed to initiate emergency postcoital contraception without additional training. As such, undergraduate training is expected to provide entry level pharmacists with the competencies required to render MCH services expected at the PHC level.

Table 6.1 The undergraduate pharmacy training integrated MCH framework as aligned with the SAPC competency standards for pharmacists that are relevant to 3 domains: public health, safe and rational use of medicines, and professional and personal practice.

Domain	Competencies	Year Level	Discipline/Module Code	Relevant MCH Knowledge	Skills/SLiP Activity/Duration
Public health	Promotion of health and wellness, medicines information, professional and health advocacy, primary health care	BPharm 1 Semester 2	Introduction to Pharmacology and Clinical Pharmacy (PHC 123)	Environmental and nutritional health (diarrhoeal disease, de-worming, Vitamin A supplementation, pregnancy supplements) (3 h)	SLiP Environmental health visit to underserved community (8 h) ORS salt and sugar dry powder preparation on campus (4 h)
Safe and rational use of medicines and medical devices	Patient consultation, patient counselling, medicines and medical devices safety, pharmacist-initiated therapy, pharmacovigilance	BPharm 2 Semester 1	Pharmacology and Clinical Pharmacy (PHC 213)		Infant growth assessment skills practical on campus (8 h)
		Semester 2	Pharmacology and Clinical Pharmacy (PHC 223)	Pregnancy care, infant carecommunicable diseases, immunization contraception part 1 (15 h)	Contraceptive products practical demonstration (2 h) SLiP-MCH program at a primary health care clinic (9 h)
Professional and personal practice	Patient-centered care, decision-making, collaborative practice, communication	BPharm 3 Semester 2	Pharmacy Practice (PPR 324)		Externship program in a retail pharmacy/health facility (48 h)
Safe and rational use of medicines and medical devices	Patient consultation, patient counselling, medicines and medical devices safety, pharmacist-initiated therapy, pharmacovigilance	BPharm 4 Semester 1	Pharmacy Practice (PPR 414)	Contraception part 2 (2 h)	

Keys: SLiP = service learning in pharmacy, MCH = maternal and child health, ORS = oral rehydration salt.

Global reforms in health professional education are directed towards strengthening the health care system through collaboration with health education institutions [10]. In resource constrained developing countries such as South Africa, the reform needs to be hinged on interventions that meet the health care needs of the majority of the population [11]. Needs based pharmacy education as proposed by the FIP Educational Initiative (FIPEd) aims to ensure that pharmacy schools are socially accountable; that practice and science are evidence-based; and pharmacy graduates have the competencies to provide the required health care services for their communities [12].

Unfortunately, traditional pharmacy department or faculty generally works along disciplines that inform curriculum development [13]. This leads to compartmentalized and

fragmented student learning where the link between the topics taught by each discipline is left to the student to decipher. This is in contrast to an integrated curriculum where the teaching method is contextual, applied, nestled, connected, and dispersed longitudinally to motivate students and enhance learning, knowledge retention, and application [14–17]. Integration also helps students to think critically and become problem solvers [18–20]. Curriculum integration in MCH has been shown to be more effective when linked with community-based learning and MCH primary health care facility engagements, which exposes students to community issues and helps to them to develop preventive thinking abilities [14,21,22].

This study follows on from an evaluation conducted in 2017 of final year pharmacy students' knowledge and skills in reproductive, maternal, new-born, and child health care at a South African university following a traditional, fragmented curriculum content exposure [3]. As a result of the evaluation, curriculum revision and longitudinal integration of MCH module content was recommended. This paper explains the development and implementation of a framework for integrated MCH curriculum content. It explores the effect of the longitudinal integration on students' knowledge and skills acquisition and retention to inform teaching and learning improvement. The study is the only one at present to our knowledge that has developed and implemented a framework for MCH training in undergraduate pharmacy education in South Africa.

2. Materials and Methods

2.1. Study Design

This was a longitudinal cohort study of undergraduate pharmacy students who were exposed to an integrated maternal and child health program in all four years of the curriculum from 2016 to 2019, with the main content concentration in the second year. The knowledge and skills of the participants in their second (2017) and fourth (2019) years of study was assessed.

2.2. The Setting

The School of Pharmacy, University of the Western Cape is the only pharmacy school in the Western Cape province of South Africa. The school has four main academic disciplines: pharmaceutical chemistry, pharmacy practice, pharmaceutics, and pharmacology and clinical pharmacy, which integrates the experiential learning component, one of which is referred to as service learning in pharmacy (SLiP). A modular system of curriculum content delivery is adopted by each discipline. In 2017, an intervention was introduced at the second-year level to improve the MCH training through curriculum content enhancement and integration in response to government initiatives to reduce the mortality rate in the country. Existing curriculum content with a bearing to the topic was identified and new content was introduced to develop a framework (Table 1) that would enhance student learning and improve their competence using multiple teaching methods.

2.3. Developing the Framework

The MCH exposure began in the second semester of the first year of study in the environmental and nutritional pathology lectures of the Introduction to Pharmacology and Clinical Pharmacy (PHC 123) module. One of the focus areas of the lecture was diarrheal disease, a communicable disease associated with neonatal and child mortality in South Africa [22]. An environmental health SLiP programme was attached to the module where students visited underserved communities accompanied by City of Cape Town environmental health practitioners to have real-life exposure to the social determinants of health and the risk factors for disease, as taught in the lecture. In addition, students were guided by qualified and authorized faculty staff to prepare dry mixtures of oral rehydration salt and sugar prepacks used in the treatment of diarrheal disease [23].

In the second year of study, an infant growth assessment practical (Figure 1) was introduced into the clinical skills training in the Pharmacology and Clinical Pharmacy

module (PHC 213) to prepare students for the MCH program in the second semester (PHC 223). The MCH program comprised of an average of 15 h of didactic lectures that concluded the on-campus training. I ran concurrently with the SLiP-MCH component, which took place at the MCH units of public PHC facilities in the Cape Town Metropole. The lectures covered the continuum of care in MCH, such as contraception (part 1 included a contraceptive products demonstration practical), preconception, pregnancy, antenatal, post-natal, and infant care, all framed within pharmacists' scope of practice. The lecture content in PHC 123 and PHC 223 was taught by the same faculty staff member (EOE). The SLiP-MCH clinic sessions took place from the second week of the semester to the eighth week. The class was split into two groups for the experiential learning sessions. Each group spent a total of 9 h for three weeks (3 h for 3 consecutive Fridays from 8:00–11:00 a.m.) at the facilities. They engaged in health educational activities to encourage and educate pregnant teenage girls on contraception, health, and well-being promotion activities for mothers and infants, and counselled mothers on medicine administration for nevirapine, vitamin A drops, oral rehydration solution (ORS), and deworming agents. In addition, they took part in infant growth assessments, charted and interpreted information in the infant 'road to health' booklet under the direct guidance of facility nurses. As part of the school's social accountability drive, the salt and sugar dry powder oral rehydration prepacks prepared by the first-year students in PHC 123 were delivered to the facilities by the second-year students during their MCH service sessions [5,16]. In the middle of the following week, a reflection session was held where faculty members helped students tease out the work-based learning that occurred at the facilities [24]. Students were required to submit an individual reflection report which rounded off the second-year MCH programme.

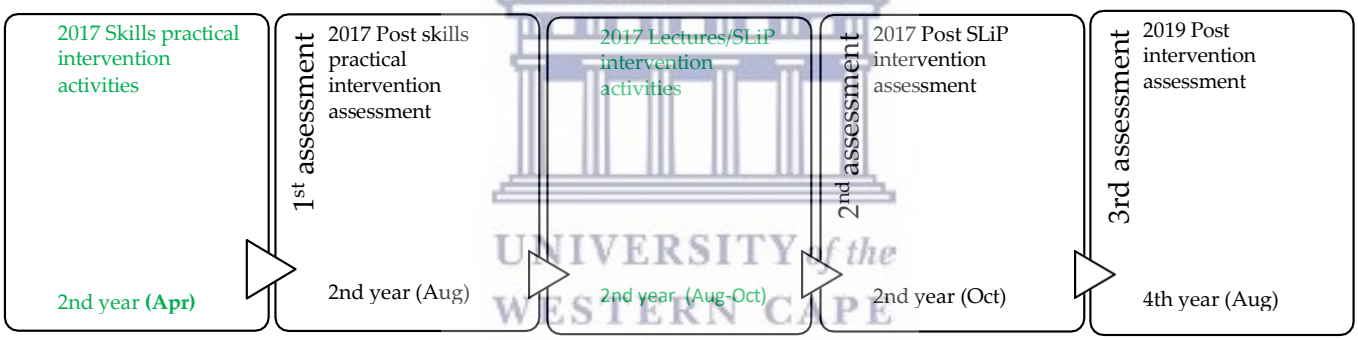

Figure 6.1 Progression of infant growth skills assessments from the practical intervention (2nd year 2017) to the 2019 post intervention assessment (two years later).

In the third year of study (2018), an MCH component was introduced into the July holiday externship program coordinated by the pharmacy practice discipline (PPR 324). Students were required to carry out self-initiated patient activities similar to the second year SLiP-MCH activities at retail pharmacies or health care facilities of their choice during the mid-year holiday externship as part of the 400 h of work-based learning required by the SAPC [25].

The MCH program was finally rounded off in the first semester of the fourth year (2019) with the concluding part of the contraception lectures [3].

2.4. Questionnaire Development

The questionnaire (see supplementary file for the questionnaires) contained 34 items that totaled 46 marks. The items consisted of 18 multiple-choice (one mark per question) and 16 short answer questions (one mark per response) which counted for 28 marks. The questionnaire was divided into three main sections A, B, and C. Section A comprised of participants' demographic details, which included age, gender, participants' first language, previous exposure to any MCH content, locum (a person who substitutes for another person from the same profession to temporarily fulfil their duties) experience, and parental

status. Section B (28 items) was the knowledge section, it had three sub-sections: reproductive and sexual health, centered on contraception (9 items, 9 marks); maternal and antenatal care, which assessed participants preconception and pregnancy care knowledge (10 items, 17 marks); and neonatal and child care, which covered infant care and nutrition, childhood diseases and immunization (9 items and 12 marks). Section C (6 items, 8 marks) assessed participants infant growth assessment skills and knowledge in a written format. Participants required a score of 50% in each knowledge subsection and the skills section of the questionnaire to pass the assessment. This was in alignment with the university's 50% pass mark.

2.5. Study Participants

In 2017, only second year pharmacy students who had taken part in the infant growth assessment practical in PHC 213 and were registered for the PHC 223 module could participate in the study. A convenience sample of 97 students consented to participate in the study.

The inclusion criteria for participating in the fourth-year study in 2019 required students to be registered at the university, to have completed the 2018 MCH component of the externship and to have participated in the second-year MCH intervention and study assessments. A purposive sample of 47 students agreed to continue with the study. This paper focuses on the 47 students who completed the three assessments.

2.6. Recruitment and Data Collection

Participants recruitment and data collection was done in two phases:

Phase 1: This phase involved 2017 second year pharmacy students who were registered for PHC 223 module (Table 1). Participant recruitment was carried out in the first week of the sec On completion of the didactic lectures, contraceptive products
the module (PHC 223). This was undertaken before the MCH didactic lectures were delivered. The researcher (EOE) explained the purpose of the study to the class and provided interested students with the study information sheet and consent form to complete and return to the researcher. The pre-intervention assessment questionnaire was handed out to a convenience sample of 97 consenting students (Figure 2) to complete in other to assess their baseline knowledge.

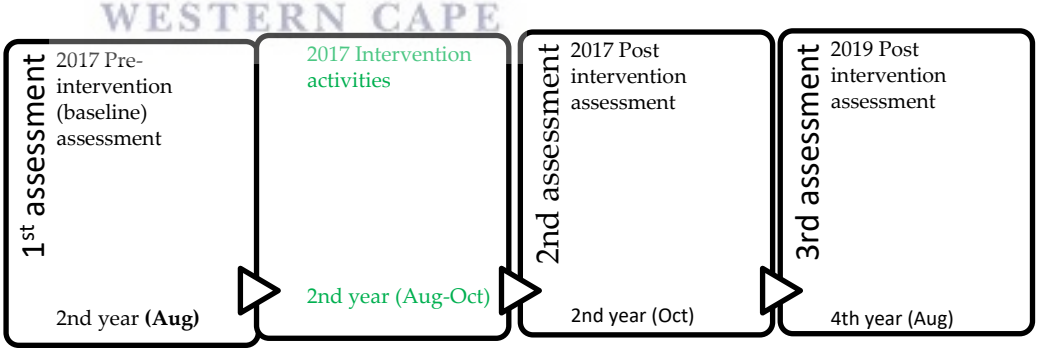

Figure 6.2 Progression of knowledge assessments from the 2017 pre-intervention to the 2019 post intervention assessment.

On completion of the didactic lectures, contraceptive products demonstration practical, SLiP-MCH clinic, and reflection sessions eight weeks after the pre-intervention assessment, a post intervention assessment was carried out using the same questionnaire and procedure. Participants were informed that they would be requested to participate in a third assessment in their fourth year of study in 2019.
Phase 2: The third assessment was carried out in 2019 at the beginning of the second semester of the participant's fourth year of study using the same questionnaire (Figure 2).

An email was sent to the fourth-year class via the university's online platform to inform them of the assessment. At a pre-arranged lecture venue and time slot, students were invited to complete the consent form and participate in the assessment. A purposive sample of 47 who had participated in the 2017 assessment students consented to participate in the assessment and complete the questionnaire.

2.7. Data Evaluation and Analysis

Three research students graded the completed questionnaires using a structured memorandum. Two other research students moderated all the graded questions. The marks were captured on an Excel spreadsheet by a research assistant and exported into the Statistical Package for Social Sciences (SPSS) version 26 for analysis [26]. One sample t-test was used to compare participants' mean scores with the average score of 50% to determine the pass rate. One-way repeated-measures analysis of variance (ANOVA) and post hoc tests were used to determine the difference in participants mean scores in the three assessments. Stepwise linear regression analysis was used to predict the effect of participants demographics on knowledge and skills acquisition and retention. Cronbach's alpha was calculated to quantify the test reliability.

3. Results

3.1. Participants Demographics

Forty-seven (47) participants completed all three assessments in the second and fourth years of their study. Most of the participants were between 18–30 years old (93.6%), and 36 (77%) were female (Table 2). None of the participants were parents in the 2017 pre and post intervention assessments. The first language of communication for 24 (51%) participants was English, while the others (49%) had an African language which included Afrikaans. Ten (21%) of the second-year participants had some knowledge of MCH prior to their exposure to the school's curriculum content through work-based experiences, information from parents or workshops or personal experiences. In the fourth year of study, one participant had done locums for more than two years, 11 others for one to two years, while 35 (75%) had never did locum.

Table 6.2 Demographic data of study participants N = 47.

	Gender	
Female		36 (77)
Male		11 (23)
	First Language	
[1] African languages		23 (49)
[2] Non-African languages		24 (51)
	Second Year	**Fourth year**
	Age (in Years)	
18 to 30	45 (96)	44 (94)
31 to 45	2 (4)	3 (6)
	Parenting Status	
No children	47 (100)	46 (98)
	Prior Exposure to MCH	
Yes	10 (21)	NA
No	37 (79)	NA
	[3] Locum Experience (in Years)	
1 to 2	NA	11 (23)
>2	NA	1 (2)

[1] African languages: All languages of African origin + Afrikaans. [2] Non-African languages: English. [3] Locum experience: a person who substitutes for another person from the same profession to temporarily fulfil their duties.

3.2. Participants' Knowledge and Skills Assessment

Results of participants performance in the three assessments was compared to the university's stipulated pass mark of 50% in Table 3. In the 2017 pre-intervention assessment, only the knowledge components were assessed. Participants' mean scores were significantly above the pass mark of 50%, except in neonatal and child care, where the mean score was significantly below 50% (43%, $p = 0.016$). The overall average score of the participants was above 50%.

In the 2017 and 2019 post intervention assessments, participants' mean scores were significantly above the 50% pass mark except in the 2019 infant growth assessment skills section where the mean score was insignificantly above the pass mark ($p = 0.187$). The mean score difference between the MCH components and the pass mark of 50% was higher the 2017 assessment.

The difference in participants' mean scores in the three assessments are compared in Table 4. The one-way repeated-measures ANOVA showed that there was a significant difference in participants mean knowledge and skills scores across the three assessments (Wilks' Lambda = 0.31, F (2, 45) = 51.0, $p = 0.0005$, multivariate partial eta squared = 0.694). A post hoc pairwise comparison using the Bonferroni correction was used in the analysis.

Table 6.3 Participants' performance in the individual components and overall assessments relative to the university stipulated pass mark of 50%. The 2017 pre-intervention assessment was a baseline assessment; the 2017 post intervention and 2019 post intervention assessments were carried out eight weeks and two years later, respectively. N = 47.

MCH Components	2017 Pre-Intervention Assessment Mean%, (MD% [1], *p*-Value [2])	2017 Post Intervention Assessment Mean%, (MD% [1], *p*-Value [2])	2019 Post Intervention Assessment Mean%, (MD% [1], *p*-Value [2])
Reproductive and sexual health	56.9 (6.9, 0.005)	73.3 (23.3, 0.000)	70.7 (20.7, 0.000)
Maternal and antenatal care	61.0 (11.0, 0.000)	79.3 (29.3, 0.000)	60.5 (10.5, 0.000)
Neonatal and child care	43.0 (−7.1, 0.016)	76.1 (26.1, 0.000)	65.4 (15.4, 0.000)
Infant growth assessment skills	[4]	74.2 (24.2, 0.000)	55.1 (5.1, 0.187)
Overall average score	53.6 (3.6, 0.045)	75.7 (25.7, 0.000)	62.9 (13.0, 0.000)
Cronbach's Alpha A (N = 34) [3]	0.575	0.745	0.776

[1] Mean Difference—the difference between the university stipulated pass mark of 50% and the mean. [2] Significant at $p < 0.05$. [3] Number of items in the questionnaire. [4] No pre-intervention (baseline) assessment.

Table 6.4 Comparison of participants' performance between assessments (N = 47).

	Mean Score % for Each Component in the Three Assessments	Mean Difference % between 2017 Pre- and Post Intervention Assessments (*p*-Value)	Mean Difference % between 2017 and 2019 Post Intervention Assessments (*p*-Value)	Mean Difference % between 2017 Pre- and 2019 Post Intervention Assessments (*p*-Value)
Reproductive and sexual health	56.9 [1], 73.3 [2], 70.7 [3]	−16.4 (0.000)	2.6 (0.283)	−13.8 (0.000)
Maternal and antenatal care	61.0 [1], 79.3 [2], 60.5 [3]	−13.4 (0.030)	18.8 (0.000)	0.5 (0.350)
Neonatal and child care	43.0 [1], 76.1 [2], 65.4 [3]	−33.2 (0.000)	10.6 (0.000)	−22.5 (0.000)
Infant growth assessment skills	74.2 [2], 55.1 [3]		19.1 (0.000)	
Overall average score	53.6 [1], 75.7 [2], 63.0 [3]	−16.3 (0.000)	12.8 (0.000)	−3.5 (0.151)

[1] 2017 Pre-intervention assessment. [2] 2017 Post intervention assessment. [3] 2019 Post intervention assessment.

Statistically significant ($p < 0.05$) increases in participants mean scores was observed between the 2017 pre- and post intervention assessments for all knowledge components evaluated in the study. The biggest increase was observed in neonatal and child care (33.2%) which had the least baseline mean score, while the smallest increase was observed in maternal and antenatal care (13.4%) which had the highest baseline mean score.

The mean difference between the 2017 and 2019 post intervention assessments showed significant decreases ($p < 0.05$) in knowledge and skills retention in all the MCH components except in reproductive and sexual health where the decrease was not significant ($p = 0.283$). The biggest decreases in knowledge retention were observed in infant growth assessment skills (19.1%) and maternal and antenatal care (18.8%).

An assessment of participants knowledge changes from baseline (pre-intervention 2017) to the 2019 post intervention assessment showed a statistically significant increase of 22.5% in neonatal and child care, and 13.8% in reproductive and sexual health ($p < 0.001$). Interestingly, participants maternal and antenatal care knowledge showed a non-significant decrease from baseline to 2019 ($p = 0.350$). The overall average score also showed a non-significant increase in knowledge ($p = 0.151$).

3.3. Effect of Demographics on Participants' Knowledge and Skills

Stepwise linear regression analysis was used to identify the statistically significant influence of the demographic variables on participants knowledge and skills mean scores in the three assessments (Table 5).

Table 6.5 Stepwise linear regression analysis of the effects of participants demographic variables on knowledge and skills scores.

Assessment	MCH Component			Unstandardized Coefficients		Standardized Coefficients		
		Model		B [1]	Std. Error	Beta [2]	T [3]	*p*-Value [4]
2017 Pre-intervention	Reproductive and sexual health	1	(Constant)	48.0	4.6		10.4	0.000
			Female	11.6	5.3	0.3	2.2	0.033
	Maternal and antenatal care	1	(Constant)	58.2	11.7		5.0	0.000
			Female	12.3	13.4	0.1	1.0	0.364
			Prior exposure (yes)	−7.9	13.9	−0.1	−0.6	0.573
	Neonatal and child care	1	(Constant)	37.5	2.7		13.8	0.000
			Prior exposure (yes)	25.4	5.9	0.5	4.3	0.000
2017 Post intervention	Reproductive and sexual health	1	(Constant)	75.3	4.9		15.4	0.000
			Female	−4.0	5.6	−0.1	−0.7	0.480
	Maternal and antenatal care	1	(Constant)	70.6	5.3		13.3	0.000
			Female	12.4	6.1	0.3	2.0	0.049
	Neonatal and child care	1	(Constant)	69.0	4.1		17.0	0.000
			Female	7.0	4.7	0.2	1.5	0.140
			Prior exposure (yes)	8.0	4.8	0.2	1.7	0.104
	Infant growth assessment skills	1	(Constant)	65.2	5.9		11.1	0.000
			Female	9.7	6.8	0.2	1.4	0.161
			Prior exposure (yes)	7.3	7.0	0.2	1.0	0.303
		2	(Constant)	73.3	3.6		20.2	0.000
			African language	2.4	6.1	0.1	0.4	0.693
2019 Post intervention	Reproductive and sexual health	1	(Constant)	68.2	4.1		16.5	0.000
			Female	1.7	4.8	0.1	0.4	0.727
		2	(Constant)	73.3	2.4		30.3	0.000
			African language	−7.3	4.0	−0.3	−1.8	0.076
	Maternal and antenatal care	1	(Constant)	55.0	5.7		9.7	0.000
			Female	5.3	6.6	0.1	0.8	0.420
	Neonatal and child care	1	(Constant)	56.9	5.3		10.7	0.000
			Female	6.8	6.1	0.2	1.1	0.269
			Prior exposure	15.2	6.3	0.3	2.4	0.020
	Infant growth assessment skills	1	(Constant)	51.8	7.7		6.7	0.000
			Female	−0.6	8.9	−0.0	−0.1	0.943
		2	(Constant)	61.0	4.5		13.4	0.000
			African language	−16.6	7.6	−0.3	−2.2	0.034

[1] B column contains the unstandardized beta coefficients that depict the magnitude and direction of the effect on the outcome variable. [2] Beta column presents unstandardized beta coefficients for each predictor variable. [3] Tolerance column presents values related to assessing multicollinearity among the predictor variables. [4] *p*-value is less than 0.05, then that variable has a significant association with the outcome variable.

Being female was on average associated with a higher mean score of 11.6% ($p = 0.033$) when responding to reproductive and sexual health questions (β = 11.6), and there was a 14% (β = 14.1) increase in female participants' infant growth assessment skills scores ($p = 0.044$) compared to males in the 2017 pre-intervention assessment. It was also associated with a higher mean score of 12% in maternal and antenatal care (β = 12.4) in the 2017 post intervention assessment. Participants with prior MCH exposure were on average, associated with a higher mean score of 25% (β = 25.4) and 15% (β = 15.2) in neonatal and child care in the 2017 pre-intervention and 2019 post intervention assessments respectively. Having an African language as a first language was associated with a lower mean score of 16% (β = −16.0) and 16.6% (β = −16.6) in participants' infant growth assessment skills mean scores in the 2017 pre-intervention and 2019 post intervention assessments respectively. Fourth year locum experience did not have any significant influence on participants' knowledge and infant growth assessment skills scores.

4. Discussion

To our knowledge, this is the first study of its kind to develop an integrated framework for undergraduate pharmacy training in MCH, which combined different components such as reproductive and sexual health, maternal and antenatal care, neonatal and child care, and infant growth assessment skills. The literature collected at the time of the publication of this work showed that most studies of this nature in Pharm D or Bachelor of Pharmacy programs focused on assessing either knowledge, perception, or curriculum content of single components of MCH, such as contraception [27–30], preconception care [31], immunization [32–34], pregnancy and breastfeeding [35,36], and pharmaceutical care for pediatrics [37] which is consistent with the traditional fragmented approach to teaching MCH.

This study aimed to develop and implement a framework for training undergraduate pharmacy students in MCH to ensure that graduating pharmacists are equipped with the required knowledge and skills.

4.1. Knowledge and Skills Assessment

Being a female was significantly associated with an increase in participants' mean score in reproductive and sexual health skills in our study. This may explain the above average mean scores observed for this component in our 2017 pre-intervention (baseline) assessment as 77% of the participants were females of reproductive age with post-high school educational exposure. This observation is supported by a cross-sectional survey of 244 rural Sierra Leone women, where 55.1% of the participants had never been to a school, and 1.2% had tertiary education [38]. The knowledge and reported practices of the women showed that those with high school or tertiary education had better general knowledge of MCH practices compared to others with primary or no formal education. Participants in the Sierra Leone study had an overall health knowledge mean score of 61.6%, although their knowledge of some health guidelines was insufficient. An awareness of the baseline knowledge of the participants in this study would enable the teaching staff to pitch the lecture content at a level that is appropriate and beneficial for students' learning. Despite participants' knowledge being above average at baseline in this study, it does not support the incidences of teenage pregnancy experienced in South Africa, where more than 20% of girls aged 15–19 years report being pregnant at least once [39]. This further supports the need for the inclusion of the appropriate level of MCH content in health professionals' training.

Generally, participants' mean scores for the MCH components and overall mean scores for the two assessments was above the university's pass mark of 50% in the 2017 and 2019 post intervention assessments, with higher mean scores than the baseline assessments. This was similar to the results observed by Zaman and Rauf (2011) following a post intervention assessment after students' exposure to an integrated MCH module [14].

The observed increase in knowledge acquisition in the 2017 post intervention (eight weeks) assessment indicated that the intervention was appropriate and successful. A similar result was obtained in a longitudinal cohort study on medical students' retention of anatomical knowledge in an integrated problem-based learning curriculum at a college in the United States of America [16]. It was observed that students entered medical school with a low level of anatomy knowledge which increased during the first-year post intervention (10 ± 9 to 46 ± 12%). In our study, the highest mean score for each knowledge component was also recorded in the assessment carried out eight weeks post intervention. This may be attributed to the freshness of the knowledge acquired immediately post intervention since the retention of knowledge potentially decreases over time. A similar result was observed in a study of three cohorts of fourth year medical students in Brazil where the retention of knowledge and clinical skills in basic pediatric cardiology was assessed immediately post intervention and six months and one year later [40]. The highest mean score was recorded in the immediate post intervention assessment with a reduction in the scores in subsequent assessments.

A significant reduction in students' knowledge retention in the 2019 post intervention assessment (two years later) was observed except in reproductive and sexual health care where the reduction was not statistically significant. An explanation for the non-statistically significant reduction in scores observed in this MCH component may be attributed to the fact that participants had received recent exposure (contraception lectures 2) before the assessment as a follow on to the lectures and practical demonstration of contraceptive products in the second year of study. Additionally, revision of second year content may have preceded the teaching of the fourth-year content which would have refreshed students' memory, subsequently aiding knowledge retention. El-Ibiary et al. (2018) suggested in their study that using several teaching methods and active lectures, such as practical demonstration workshops and assignments in reproductive and sexual health enhanced students' knowledge and confidence [41]. Other authors also indicated that a high level of knowledge retention can be achieved through the use of active learning methods and longitudinal reinforcement as a result of content integration across the four years of the study [16,42].

Conversely, the reduction in knowledge retention in the 2019 post intervention assessment can be attributed to non-use or non-practice, which leads to long retention intervals. Historical data suggests that substantial knowledge decay is observed in general education knowledge with 70% retention after 1 year of nonuse; 40–50% after 2 years; 30% after 4 or more years [17]. However, the retention of basic science knowledge from medical school was found to be better depending on frequency of use or reinforcement.

Despite the considerable knowledge increase observed in the 2017 post intervention assessment in the maternal and antenatal care component, which was correlated to the high number of female participants in the study, participants knowledge in the 2019 post intervention study dropped to the 2017 pre-intervention state indicating the high knowledge reduction that occurred in the two-year interval. One of the reasons that may be proffered for this observation may be explained from the result of the study carried out by Peng et al. (2019) where they observed that the adequacy or appropriateness of teacher knowledge transfer significantly influences students' absorptive capacity and learning outcomes [43]. As such, lecture content and method of teaching must be pitched at a higher level compared to student's prior knowledge. In addition, participants learning outcomes may be compromised due to the knowledge of the current practice in South Africa where maternal and antenatal care services are provided by nurses at PHC facilities and in the rapidly expanding big chain community pharmacies [44]. This may have detracted from the experience leading undergraduate pharmacy students to believe that they do not have a role in MCH [3].

No baseline assessment was carried out for the infant growth assessment skills component due to timetable constraints (Figure 1). Although the 2017 post intervention assessment took place six months after the initial exposure, the participants recorded a mean

score of 74.2%, which indicated adequate infant growth assessment skills and knowledge acquisition and retention. However, the mean score obtained in the 2019 post intervention assessment was significantly reduced to 55.1%. This may be attributed to non-use or insufficient practice of the acquired skills in the time period between the assessments although participants carried out an MCH component in a third-year externship. One of the reasons for the lack of practice would be the subtle elimination of pharmacists from MCH service delivery in pharmacies through the nurse–pharmacist alliances that exist especially in big chain retail pharmacies where most MCH services are provided by nurses [44]. Therefore, undergraduate pharmacy students who work either as post basic pharmacist's assistants from the second year of study or locum pharmacist's assistants from the fourth year of study in health facilities may have none or a few privileges of encountering MCH cases. A meta-analysis of the factors that influence skill loss and retention by Arthur et al. (1998) lends credence to the impact of non-use interval on skill retention [45]. He opined that there is a negative or inverse relationship between skills retention and the length of non-practice interval; as one increased, the other would decrease. He carried out a quantitative analysis of the relationship and showed that after more than one year of non-practice interval of a skill, performance reduces to less than 92% of the capability before the non-use interval. In addition, Amaral and Troncon (2013) observed in their study that participants' clinical and physical examination skills was retained and tended to increase in areas where the opportunity for practicing the skills was more frequent after the initial acquisition in contrast to less frequently used skills such as the interpretation of chest radiographs and electrocardiogram which reduced significantly [40].

However, since 2016, the SAPC has advocated that undergraduate training in MCH should include hands-on practice of infant growth assessment at PHC facilities. This training requirement is in line with the GPP documented baby and child health, and immunization services that pharmacists can offer. To offer these services, the GPP stipulated that a pharmacy must have the road to health booklet for babies, a baby weighing scale, height chart, and tape measure [8]. Pharmacists' ability to carry out practical, measurement based baby and infant growth assessments will enable them to provide evidence-based advice to parents and carers [3]. This is especially important in sub-Saharan Africa where health care professional shortages are rife and public health care facilities are underfunded and overwhelmed [24]. Ironically, in contrast to the South African scenario, the trend in developed countries with better health care system and lower patient to practitioner ratios, pharmacists are involved in and specializing in MCH service provision [46–48].

4.2. Limitations and Recommendations

The study was carried out at one pharmacy school in South Africa with a single cohort of participants, and as such, the results may not be generalizable. The result may not be a true reflection of the class performance as purposive sampling was used in the 2019 post intervention assessment (only students who participated in the two previous assessments were included in the study). The same tool was used throughout the study so students may have become familiar with the questions although students were not provided with the answers to the questions at any point. Since the assessments did not count for course grade, the stakes where low for the participants and this may have affected their performance. Infant growth assessment skills were examined in a written assessment rather than the traditional objective structured clinical examination or practical evaluation due to lack of adequate man power. This may undermine the result of that section.

Further studies on factors that may reinforce students' knowledge and skills in MCH and improve integration of content are recommended. A study on the knowledge and practices of pharmacists in MCH in South Africa is also suggested.

5. Conclusions

A framework for an integrated program for undergraduate pharmacy education in MCH was developed and implemented longitudinally across all four years of study. The

framework was underpinned by the SAPC GPP, competency standards, high mortality rates and the need to meet the SDG targets by 2030, MCH health workforce shortages, and task sharing. To ensure that adequate knowledge acquisition occurs, lecture content must be appropriately pitched above students' baseline knowledge. The introduction of new active learning strategies and longitudinal dispersion of curriculum content across a student's years of study has been shown to aid knowledge retention. In addition, avenues for undergraduate pharmacy students to carry out work-based learning using their MCH knowledge and skills are important to enhance retention.

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References

1. Department of Health, Republic of South Africa. *Strategic Plan for Maternal, Newborn, Child and Women's Health (MNCWH) and Nutrition in South Africa 2012–2016*; Department of Health: Pretoria, South Africa, 2012.
2. National Department of Health, Republic of South Africa. *Guidelines for Maternity Care in South Africa*; National Department of Health, Republic of South Africa: Pretoria, South Africa, 2015; pp. 1–174.
3. Egieyeh, E.; Van Huyssteen, M.; Coetzee, R.; Bheekie, A. Evaluating pharmacy students' knowledge and skills in reproductive, maternal, new-born and child health care at a South African university. *BMC Med. Educ.* **2021**, *21*, 1–16. [CrossRef]
4. Christofides, N.J.; Jewkes, R.K.; Dunkle, K.L.; McCarty, F.; Shai, N.J.; Nduna, M.; Sterk, C. Risk factors for unplanned and unwanted teenage pregnancies occurring over two years of follow-up among a cohort of young South African women. *Glob. Health Action* **2015**, *7*, 8. [CrossRef] [PubMed]
5. World Health Organization. Health in 2015: From MDGs, Millennium Development Goals to SDGs, Sustainable Development Goals. World Health Organization, 2015. Available online: http://who.int/gho/publications/mdgs-sdgs/en/ (accessed on 29 July 2021).
6. International Pharmaceutical Federation (FIP). *FIP Statement of Policy on the Effective Utilization of Pharmacists in Improving Maternal, Newborn and Child Health (MNCH)*; International Pharmaceutical Federation: The Hague, The Netherlands, 2013. Available online: https://www.fip.org/files/fip/publications/FIP_Statement_of_Policy_MNCH_2013_Final.pdf (accessed on 10 September 2021).
7. Kerber, K.J.; de Graft-Johnson, J.E.; Bhutta, Z.A.; Okong, P.; Starrs, A.; Lawn, J.E. Continuum of care for maternal, newborn, and child health: From slogan to service delivery. *Lancet* **2007**, *370*, 1358–1369. [CrossRef]

8. South African Pharmacy Council. *Good Pharmacy Practice Manual and Associated SAPC Rules Good Pharmacy Practice in South Africa*; South African Pharmacy Council: Pretoria, South Africa, 2017; p. 194. Available online: http://www.pharmcouncil.co.za/G_PublicationsD.asp (accessed on 29 July 2021).
9. South African Pharmacy Council. *Competency Standards for Pharmacists in South Africa*; South African Pharmacy Council: Pretoria, South Africa, 2017. Available online: https://www.mm3admin.co.za/documents/docmanager/0C43CA52-121E-4F58-B8F6-81F656F2FD17/00126360.pdf (accessed on 13 May 2021).
10. Frenk, J.; Chen, L.; Bhutta, Z.A.; Cohen, J.; Crisp, N.; Evans, T.; Fineberg, H.; Garcia, P.P.; Ke, P.Y.; Kelley, P.; et al. Health professionals for a new century: Transforming education to strengthen health systems in an interdependent world. *Lancet* **2010**, *376*, 1923–1958. [CrossRef]
11. Bheekie, A.; Van Huyssteen, M.; Coetzee, R. Exploring the Implications of a Needs-Based Pharmacy Education Framework Modelled on Population Health: Perspective from a Developing Country. *Pharmacy* **2019**, *7*, 116. [CrossRef]
12. Anderson, C.; Bates, I.; Beck, D.; Brock, T.P.; Futter, B.; Mercer, H.; Rouse, M.; Whitmarsh, S.; Wuliji, T.; Yonemura, A. The WHO UNESCO FIP Pharmacy Education Taskforce. *Hum. Resour. Health* **2009**, *7*, 45. [CrossRef]
13. Koster, A.; Schalekamp, T.; Meijerman, I. Implementation of Competency-Based Pharmacy Education (CBPE). *Pharmacy* **2017**, *5*, 10. [CrossRef]
14. Zaman, I.F.; Rauf, A. Working toward Decreasing Infant Mortality in Developing Countries through Change in the Medical Curriculum. *Asia Pac. Fam. Med.* **2011**, *10*, 11. [CrossRef]
15. Pearson, M.L.; Hubball, H.T. Curricular integration in pharmacy education. *Am. J. Pharm. Educ.* **2012**, *76*, 204. [CrossRef] [PubMed]
16. Mcbride, J.M.; Drake, R.L. Longitudinal cohort study on medical student retention of anatomical knowledge in an integrated problem-based learning curriculum. *Med. Teach.* **2016**, *38*, 1209–1213. [CrossRef] [PubMed]
17. Custers, E.J.F.M. Long-term retention of basic science knowledge: A review study. *Adv. Health Sci. Educ.* **2010**, *15*, 109–128. [CrossRef]
18. Poirier, T.I.; Fan, J.; Nieto, M.J. Survey of Pharmacy Schools' Approaches and Attitudes toward Curricular Integration. *Am. J. Pharm. Educ.* **2016**, *80*, 6–96. [CrossRef] [PubMed]
19. Al-Hreashy, F.; Al-Kadri, H.; Al-Mobeirek, A.; Scherpbier, A. A mixed-method evaluation of the views of medical teachers on the applicability of the "infant and young child feeding chapter" in Saudi medical colleges. *BMC Med. Educ.* **2018**, *18*, 232. [CrossRef] [PubMed]
20. Islam, M.A.; Schweiger, T.A. Students' perception of an integrated approach of teaching entire sequence of medicinal chemistry, pharmacology, and pharmacotherapeutics courses in PharmD curriculum. *J. Pharm. Pract.* **2015**, *28*, 220–226. [CrossRef]
21. Buckner, A.V.; Ndjakani, Y.D.; Banks, M.B.; Blumenthal, D.S. Using service-learning to teach community health: The Morehouse School of Medicine Community Health Course. *Acad. Med. J. Assoc. Am. Med. Coll.* **2010**, *85*, 1645. [CrossRef]
22. Ryan, T.J.; Grimes, T.; Henman, M.C.; Sheachnasaigh, E.N.; O'Dwyer, M.; Roche, C.; Ryder, S.A.; Sasse, A.; Walsh, J.J.; D'Arcy, D.M. Design and Implementation of an Integrated Competency-Focused Pharmacy Programmeme: A Case Report. *Pharmacy* **2019**, *7*, 121. [CrossRef]
23. Chola, L.; Michalow, J.; Tugendhaft, A.; Hofman, K. Reducing diarrhoea deaths in South Africa: Costs and effects of scaling up essential interventions to prevent and treat diarrhoea in under-five children. *BMC Public Health* **2015**, *15*, 394. [CrossRef] [PubMed]
24. Van Huyssteen, M.; Bheekie, A. The hidden curriculum of work-based learning for pharmacy students in public sector pharmacies in South Africa. *Pharm. Educ.* **2017**, *17*, 190–198.
25. Ilcewicz, H.N.; Coetzee, R.; Taylor, M.; Piechowski, K.; Martello, J.L.; Wietholter, J.P. Evaluation of pharmacy students' perceptions of clinical pharmacy in South Africa. *J. Am. Coll. Clin. Pharm.* **2020**, *3*, 1065–1071. [CrossRef]
26. IBM. *IBM SPSS Statistics for Windows 2019 Version 26*; IBM: Armonk, NY, USA, 2019.
27. Rim, C.; El-Ibiary, S.Y.; Rafie, S.; Borgelt, L.M. Assessment of contraceptive curricula in US pharmacy programmes. *Curr. Pharm. Teach. Learn.* **2020**, *12*, 395–399. [CrossRef] [PubMed]
28. Elkalmi, R.M.; Khan, M.U.; Binti, H.; Hadi, A. Knowledge, awareness, and perception of contraception among senior pharmacy students in Malaysia: A pilot study. *J. Res. Pharm. Pract.* **2015**, *4*, 94–98. [PubMed]
29. Richman, A.R.; Daley, E.M. Exploring Emergency Contraception Knowledge among Florida Pharmacy School Students. A Preliminary Assessment. *Women's Health Issues* **2009**, *19*, 373–380. [CrossRef] [PubMed]
30. Hope, D.L.; Hattingh, H.L.; King, M.A. Australian pharmacy students' knowledge, attitudes, and behaviours regarding emergency contraception. *Pharm. Educ.* **2016**, *16*, 11–17.
31. Ng, C.; Najjar, R.; DiPietro Mager, N.; Rafie, S. Pharmacist and student pharmacist perspectives on providing preconception care in the United States. *J. Am. Pharm. Assoc.* **2018**, *58*, 426–431. [CrossRef] [PubMed]
32. Kubli, K.; McBane, S.; Hirsch, J.D.; Lorentz, S. Student pharmacists' perceptions of immunizations. *Curr. Pharm. Teach. Learn.* **2017**, *9*, 479–485. [CrossRef] [PubMed]
33. Prescott, W.A.; Bernhardi, C. Immunization Education in US Pharmacy Colleges and Schools. *Am. J. Pharm. Educ.* **2019**, *83*, 6765. [CrossRef] [PubMed]
34. Alshammari, E. Students' knowledge and attitude toward safety of influenza vaccine injection during pregnancy and for children. *Int. Res. J. Pharm.* **2018**, *9*, 53–55. [CrossRef]

35. Grimm, R.; Knickerbocker-Manns, A.; Saldamando, D. *Evaluation of the University of Arizona College of Pharmacy's Curriculum and Pharmacy Students' Knowledge and Abilities to Counsel Women about the Use of Over-the-Counter Products and Prescription Medications During Pregnancy and Breastfeeding;* The University of Arizona Libraries: Tucson, AZ, USA, 2009.
36. Edwards, R.A. Expanding pharmacists' roles in breastfeeding support: A pilot study of an online breastfeeding tutorial for student pharmacists. *Curr. Pharm. Teach. Learn.* **2013**, *5*, 129–133. [CrossRef]
37. Mukattash, T.L.; Jarab, A.S.; Abu-farha, R.K.; Alefishat, E.; Mcelnay, J.C. Pharmaceutical Care in Children: Self-reported knowledge, attitudes and competency of final-year pharmacy students in Jordan. *Sultan Qaboos Univ. Med. J.* **2018**, *18*, 68–475. [CrossRef]
38. Kanu, J.S.; Tang, Y.; Liu, Y. Assessment on the Knowledge and Reported Practices of Women on Maternal and Child Health in Rural Sierra Leone: A Cross-Sectional Survey. *PLoS ONE* **2014**, *9*, 8. [CrossRef]
39. Chola, L.; McGee, S.; Tugendhaft, A.; Buchmann, E.; Hofman, K. Scaling Up Family Planning to Reduce Maternal and Child Mortality: The Potential Costs and Benefits of Modern Contraceptive Use in South Africa. *PLoS ONE* **2015**, *10*, 6.
40. Amaral, F.; Troncon, L.E.D.A. Retention of Knowledge and Clinical Skills by Medical Students: A Pro-spective, Longitudinal, One-Year Study Using Basic Pediatric Cardiology as a Model. *Open Med. Educ. J.* **2013**, *6*, 48–54. [CrossRef]
41. El-Ibiary, S.Y.; Azizoddin, A.; Petrossian, L.; Gurney, M.K. Implementation and evaluation of a women's reproductive health pharmacy elective. *Curr. Pharm. Teach. Learn.* **2018**, *10*, 1087–1096. [CrossRef] [PubMed]
42. Raman, M.; McLaughlin, K.; Violato, C.; Rostom, A.; Allard, J.P.; Coderre, S. Teaching in small portions dispersed over time enhances long-term knowledge retention. *Med. Teach.* **2010**, *32*, 250–255. [CrossRef] [PubMed]
43. Peng, Y.P.M.; Zhang, Z.; Ho, S.S. A Study on the Relationship among Knowledge Acquisition Sources at the Teacher- and College-Level, Student Absorptive Capacity, and Learning Outcomes: Using Student Prior Knowledge as a Moderator. *Educ. Sci. Theory Pract.* **2019**, *19*, 22–39.
44. Gilbert, L. Pharmacist and nurse: A team approach towards primary health care or a convenient "therapeutic alliance"? *Int. J. Nurs. Stud.* **1997**, *34*, 367–374. [CrossRef]
45. Arthur, W.; Bennett, W.; Stanush, P.L.; McNelly, T.L. Factors that influence skill decay and retention: A quantitative review and analysis. *Hum. Perform.* **1998**, *11*, 57–101. [CrossRef]
46. Stanford Children's Health. Lucille Packard Children's Hospital, Stanford. Children's Home Pharmacy. Available online: https://www.stanfordchildrens.org/en/service/childrens-home-pharmacy (accessed on 17 June 2021).
47. Whitfield, K. The emerging role of the women's and newborns' pharmacist. *J. Pharm. Pr. Res.* **2017**, *47*, 254–255. [CrossRef]
48. Ayele, A.A.; Islam, M.S.; Cosh, S.; East, L. Involvement and practice of community pharmacists in maternal and child health services: A systematic review. *Res. Soc. Adm. Pharm.* **2021**, *17*, 643–652. [CrossRef]

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CHAPTER SEVEN: Comparative evaluation of pharmacy students' knowledge and skills in maternal and child health: traditional versus integrated curriculum

In this chapter, a research paper entitled:

"Comparative evaluation of pharmacy students' knowledge and skills in maternal and child health: traditional versus integrated curriculum", is presented. It was published as a research article in MDPI Pharmacy 2022, 10, 62. https://Doi.org/10.3390/ pharmacy10030062. It has been used in this thesis as an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

The research paper presented in this chapter covers the third phase (phase 3) of the research project which involved cohorts 2 (2017), 3 (2018) and 4 (2019) in a comparative evaluation of the fragmented and integrated curriculum using the mean scores obtained by the final (fourth) year participants in the questionnaire assessments in phases 1 and 2. The result obtained showed that the highest mean scores were recorded by the 2019 cohort. Overall, the integrated MCH curriculum and the longitudinal dispersion of content enhanced students' knowledge and skills.

The research paper was published in the journal- MDPI Pharmacy because it is a follow-up to the phase two paper presented in chapter six that was previously published in the same journal.

pharmacy

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Article

Comparative Evaluation of Pharmacy Students' Knowledge and Skills in Maternal and Child Health: Traditional versus Integrated Curriculum

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Abstract: Reducing maternal and child mortality is a health priority in South Africa. Therefore, health professional education should produce graduates that can meet these needs. This study compared the maternal and child health (MCH) knowledge and skills of cohorts of final-year students exposed to a traditional (in 2017 and 2018) and integrated (2019) curriculum using a 34-item questionnaire. Between the 2019 and 2017 cohorts, ANOVA and post hoc analysis showed significant differences in the reproductive and sexual health component which was dispersed in the second and final years of study (p = 0.007, Mean Difference (MD) = 8.3) andneonatal and child care (p = 0.000, MD = 15). while it was only in maternal and antenatal care (p = 0.009, MD = 10.0) for the 2019 and 2018 cohorts. Significant differences were observed in participants' average mean scores (p = 0.000 for 2018 and 2017). The highest mean scores were recorded by the 2019 cohort in the three assessments. A one-sample t-test showed the highest mean differences in the reproductive and sexual health components (p = 0.000; MD 2017 = 12.4, MD 2018 = 14.8, MD 2019 = 20.7). Overall, the integrated MCH curriculum and the longitudinal dispersion of content enhanced students' knowledge and skills.

Keywords: curriculum; traditional; integrated; final year pharmacy students; maternal and child health; knowledge; skills; South Africa

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1. Introduction

Like many sub-Saharan African countries, South Africa grapples with the burden of maternal and child mortality (MCM) [1]. To achieve the targets of the Sustainable Development Goal (SDG) 3 for the reduction of MCM, South Africa aims to half its current institutional maternal (120 per 100,000 live births in 2019) and neonatal mortality (25 deaths per 1000 live births in 2018) by 2030 [2].To accomplish this goal, a maternal, perinatal, and neonatal health (MPNH) policy that offers a framework for delivering valuable, all-inclusive, and cohesive maternal and neonatal services was developed [2]. The scope of the policy covers all interventions aimed at improving the health outcomes of individuals during the reproductive lifecycle. In addition, the policy intends to focus on all front-line workers to ensure universal health coverage through the National Health Insurance (NHI) plan.

Although pharmacists are not mentioned as part of the MCH workforce in the MPNH policy, their roles cover interventions in obstetric pharmacotherapy health promotion and disease prevention activities in contraception, preconception, pregnancy and infant care that target drivers of MCM similar to those outlined in the policy [3–5]. The provision of health promotion and preventive care is one of the goals of primary health care (PHC) as an antidote to some emergency obstetric care needs in MCH in South Africa [6]. Despite

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these potentials, community pharmacy operations are often disconnected from national population-based primary care programmes due to the fragmented health care system in South Africa [7].

Integrating pharmacy MCH services into the mainstream national MPNH policy would further enhance these contributions, foster accountability, and promote health system strengthening, which is a priority of the National Development Plan 2030 [8,9]. The need for integration has become urgent and demands that proven interventions be scaled up and accelerated since the onset of the COVID-19 pandemic [10]. The situation was emphasised in recent publications that projected a global reversal of the progress made to reduce MCM in the past three decades, which was attributed to the impact of the pandemic [10–14]. A South African Medical Research Council publication reported a double pandemic in the country due to the rise in adolescent pregnancy in this period [10]. One of the reasons for the rise was the lack of access to contraceptives at public PHC facilities during the hard lockdown. The author recommended that free contraceptives should be provided at schools, community settings, and community pharmacies where advocacy messages can also be promoted, such as in the health care facilities.

However, studies from several countries have shown that most practising pharmacists feel uncomfortable and ill-prepared to render MCH services [5,15,16]. Inadequate curriculum exposure, lack of relevant resources and continuing professional development in MCH were identified as some of the reasons for the ineptitude observed [5,16,17].

Like most discipline-based curricula, the traditional pharmacy curriculum is teacher-centred, non-contextualised and compartmentalised, leading to fragmented learning in silos and inadequately trained graduates [18,19]. In a study carried out at a medical school in Pakistan, one of the reasons hypothesised for the lack of reduction in the high rate of MCM was the fragmented MCH curriculum adopted at the school [20]. By introducing an integrated MCH curriculum through a team that cut across disciplines such as obstetrics and gynaecology, paediatrics, community medicine, pathology, and pharmacology, students' knowledge, skills and ability to resolve difficult issues related to infant mortality were enhanced.

Curriculum integration involves the deliberate fusing or scaffolding of a premeditated educational experience either vertically or horizontally [19,21]. An integrated curriculum offers educational experiences that are coherent, contextual, engaging, nestled, connected, and dispersed longitudinally to motivate students and enhance learning, knowledge retention, and application [22]. In addition, it helps students to develop higher-order learning and problem-solving abilities [19,20]. In undergraduate MCH training, the effectiveness of curriculum integration is consolidated when linked with community-based learning and MCH PHC facility engagements, which foster preventive thinking skills and multisectoral collaboration [2,20,21].

For pharmacy to be socially accountable in MCH, the priority health needs of the nation should underpin undergraduate curricula. 'Entry-level' pharmacists should be knowledgeable and appropriately skilled to offer essential services [23,24]. The study follows two previously published studies. The first was an evaluation of the knowledge and skills of 2017 final-year pharmacy students that were exposed to a traditional, fragmented MCH curriculum [25]. The result obtained from the first study showed a knowledge and skills gap hypothesised to be associated with the traditional curriculum. Subsequently, a framework for an integrated MCH curriculum was developed and implemented [22]. The current paper compared the effect of the two exposures on students' knowledge and skills for teaching and learning improvement. To our knowledge, the study is the only one at present that has compared a traditional and an integrated MCH curriculum in undergraduate pharmacy education in South Africa.

2. Materials and Methods

2.1. Study Design

The longitudinal, comparative evaluation study assessed the MCH knowledge and skills of three cohorts of final year (fourth year) undergraduate Bachelor of Pharmacy (BPharm IV) students from 2017 to 2019. The 2017 and 2018 cohorts were exposed to a traditional MCH curriculum in all four years of their study from 2014 and 2015 [25]. The 2019 cohort participated in the intervention to integrate the curriculum from the second (2017) to the final year of study. As such, the cohort had three exposures to the same questionnaire: pre and post intervention in 2017 (eight weeks apart) and two years later in the final year [22]. The MCH content of the curriculum was concentrated in the second year of study in both exposures [22,25].

2.2. The Traditional Curriculum

The content of the traditional MCH curriculum included lectures on pregnancy and infant care, communicable diseases, immunisation, and contraception. Due to timetable constraints, the pharmacology and clinical pharmacy discipline taught all other topics except for contraception in a 2 h crash course (Table 1). However, contraception lectures were taught by the pharmacy practice discipline and split into two parts that were longitudinally dispersed in the second (contraceptive methods in the National Standard Treatment Guidelines and Essential Medicines List (STGs and EML) at the PHC level) and final years of study (contraceptive methods not that are not available in the STGs and EML) [26]. The second-year lectures prepared the students for the Service-Learning in Pharmacy (SLiP) sessions at the MCH units of PHC facilities in the Cape Town metropole under the direct supervision of facility nurses [22,25]. Although students were exposed to these topics, the link between the topics and the continuum of care in MCH was not established. As such, students were completely ignorant of the broader concept of MCH; they only understood each topic in isolation, which led to compartmentalised and fragmented learning [25].

2.3. The Integrated Curriculum (The Intervention)

In response to government's initiatives to reduce the MCM rate in the country, an intervention was introduced in 2017 at the second-year level to develop an integrated framework for MCH education at the school [22]. The framework aligned with three SAPC domains and the corresponding competencies (Table 1). Existing curriculum content with bearing to the continuum of care in MCH was identified at each year level, revised where necessary, and incorporated into the framework. An example is the communicable diseases lectures that were streamlined and contextualised to focus only on childhood communicable diseases. At the same time, emphasis was laid on the expanded programme on immunisation in South Africa in the immunisation lectures. In addition, new content such as preconception lecture and infant growth assessment practical were included in the framework at the second-year level, and an MCH externship (48 h training programme in a pharmacy or PHC facility undertaken during the mid-year holiday) component was introduced in the third year of study to complete the vertical integration.

Table 7.1 MCH framework indicating the traditional and integrated content per year of study aligned with three SAPC domains and competencies.

Traditional MCH Curriculum Content for the 2017/2018 Cohort				Integrated MCH Curriculum Content for the 2019 Cohort				
Discipline/Module Code	Semester	Lecture component/ Duration	Skills/SliP [2] Activity/Duration	SAPC [6] Domain	Competencies	Semester	Lecture Component/Duration	Skills/SLiP Activity/ Duration
Introduction to Pharmacology and Clinical Pharmacy (PHC 123)	BPharm [1] 1 Semester 2 (2014/2015)	Environmental and nutritional health (diarrhoeal disease, deworming, Vitamin A supplementation) (3 h)	SLiP Environmental health visit to an underserved community (8 h) ORS [3] salt and sugar dry powder preparation on campus (4 h)	Public health	Promotion of health and wellness, medicines information, professional and health advocacy, primary health care	BPharm 1 (2016)	The relevant module content was not integrated into MCH until 2018.	
Pharmacology and Clinical Pharmacy (PHC 213)				Safe and rational use of medicines and medical devices	Patient consultation, patient counselling, medicines, and medical devices safety, pharmacist-initiated therapy, pharmacovigilance	BPharm 2 Semester 1 (2017)	Pre-pregnancy and antenatal care, pregnancy care, infant care, communicable diseases of childhood, immunisation against diseases of childhood (EPI [7]), contraception part 1 (15 h)	Infant growth assessment skills practical on campus (8 h)
Pharmacology and Clinical Pharmacy (PHC 223)	BPharm 2 Semester 2 (2015/2016)	Pregnancy care, infant care communicable diseases, immunisation (2 h crash course), contraception part 1 (2 h)	Contraceptive products practical demonstration (2 h) SLiP-MCH [4] programme at a PH5 [5] facility (9 h)			BPharm 2 Semester 2 (2017)		Contraceptive products practical demonstration (2 h) SLiP-MCH programme at a PHC facility (9 h)
Pharmacy Practice (PPR 324)				Professional and personal practice	Patient-centred care, decision making, collaborative practice, communication	BPharm 3 Semester 2 (2018)		Externship programme at a retail pharmacy or PHC facility (48 h)
Pharmacology and Clinical Pharmacy (PHC323)	BPharm 3 Semester 2 (2016/2017)	Reproductive hormones (2 h)					Participants were exposed to the relevant module content although it was not integrated.	
Pharmacy Practice (PPR 414)	BPharm 4 Semester 1 (2017/2018)	Contraception part 2 (2 h)		Safe and rational use of medicines and medical devices	Patient consultation, patient counselling, medicines, and medical devices safety, pharmacist-initiated therapy, pharmacovigilance	BPharm 4 Semester 1 (2019)	Contraception part 2 (2 h)	

[1] Bachelor of Pharmacy, [2] Service-learning in Pharmacy, [3] Oral rehydration solution, [4] Service-learning in pharmacy: maternal and child health, [5] Primary health care, [6] South African Pharmacy Council, [7] Expanded Programme on Immunisation.

To integrate the espoused, enacted, and experienced curriculum, an orientation session was organised in 2017 at the beginning of the second semester of the second year of study in the pharmacology and clinical pharmacy module (PHC223), where the main intervention was implemented [19,22]. The integrated framework used an instructional scaffolding design to promote competence in MCH knowledge and skills [27]. Students were informed of the components of the framework and the different year levels at which they would be exposed to each. The significance of the framework to pharmacists' roles in MCH and the country's high mortality and teenage pregnancy rate was highlighted during the orientation session. The link between each component (topic or activity) and the continuum of MCH care was established at the orientation session and during each contact session by the lecturer (primary author, EE) to ensure clarity and integration of content. Students were invited to participate in a longitudinal study two years later in their final year of study [22]. Different teaching methods such as infant growth assessment practical, contraceptive products demonstrations, didactic lectures, and experiential learning sessions (Table 1) at MCH units of PHC facilities under the direct supervision of facility nurses (for inter- professional and multisectoral collaboration) were included in the framework [2,22,28]. Students were encouraged to identify a gap in service delivery that they could fill at each health facility [29]. Assessments were carried out using different methods such as quizzes, tests, reflective writing, group case study, practical demonstrations, and final examinations within the allocated modules and in line with university regulations (Table 2). Other exposures to these topics horizontally or otherwise may have been through references to the importance of health education and medication safety in pregnancy and paediatrics offered during the other undergraduate course content in pharmaceutics, pharmaceutical chemistry, and pharmacotherapy lectures.

Table7. 2 The integrated MCH framework content and the associated assessment tools.

Year of Study	Lecture Topic/Activity	Assessment Tools
BPharm 1	Environmental and nutritional health lectures	Quiz, test, final exam
	SLiP [1] Environmental health visit to an underserved community	Reflection report writing, supervised ORS [2] dry powder preparation
BPharm 2 Semester 1	Infant growth assessment skills practical on campus	Group work on assigned cases
BPharm 2 Semester 2	Pre-pregnancy and antenatal care, pregnancy care, infant care	Quiz, test, final exam
	Communicable diseases of childhood, immunisation, contraception part 1	
	SLiP-MCH [3] programme at a primary health care facility	Quiz, reflection report writing
	Contraceptive products practical demonstration	Group work on assigned cases
BPharm 3 Semester 2	Externship programme in a retail pharmacy/health care facility	Reflection report writing
BPharm 4 Semester 1	Contraception part 2	Quiz, test, final exam

[1] Service-learning in Pharmacy, [2] Oral rehydration solution, [3] Service-learning in pharmacy-maternal and child health.

2.4. Study Participants

A total of 142 students participated in the study. The 2017 and 2018 cohorts had 54 and 41 participants, respectively, while the 2019 cohort had 47 participants. The criteria for participation in the 2019 assessment included participation in the 2017 MCH pre and post-intervention assessments and completion of the 2018 MCH component of the externship [22]. Participants who repeated third-year pharmacology and clinical pharmacy modules were excluded from the 2017 and 2018 assessments [25].

2.5. Study Questionnaire

The questionnaire was developed in 2017 (see the Supplementary Materials for the questionnaire) and used in the three studies. The structure and content were developed from different sources such as previous similar studies, the interventions outlined in the FIP statement of policy and the SAPC GPP guidelines for MCH [16,20,30–32]. The appropriateness, readability, clarity and length of the content of the 34-item questionnaire were assessed by four faculty versed in the subject, five final-year students recruited as

assistant researchers and another eight final-year students who participated in the pilot test [25]. The pilot test was carried out once with one group of students in 2017. The questionnaire had three main Sections A–C. Section A contained questions on participants' demographics, including locum experience (a person who substitutes for another person from the same profession to fulfil their duties temporarily) and parental status.

Section B had 28 items that assessed participants' knowledge using three MCH components; B1 was reproductive and sexual health, which focused on contraception knowledge (9 items, 9 marks); B2 was maternal and antenatal care, which covered preconception and pregnancy care (10 items, 17 marks); B3 was neonatal and child care, which covered infant care, nutrition, childhood diseases, and immunisation (9 items, 12 marks). Section C was a written evaluation of participants' infant growth assessment skills and knowledge (6 items, 8 marks). More information about the questionnaire development can be accessed from previously published articles on the study [22,25].

2.6. Recruitment and Data Collection

As much as possible, the same procedures were followed to recruit participants and collect data in the three assessments. Information about the study was provided to each class through emails sent by the primary author (EOE) using the university's electronic communication platform. In addition, each year, six students who were allocated to the study as student researchers to meet course requirements for their final-year projects provided information and updates to the class. The class was informed that participation in the study was voluntary. Participant recruitment took place during a regular lecture period and at a designated venue where all final-year students were in attendance. Interested students were given the study information sheet and asked to complete the consent form before completing the self-administered questionnaire. Completion of the questionnaire mimicked the protocol required for a class test. The research assistants and the primary author served as invigilators. Completed questionnaires were returned to the researchers after 60 min [22,25]. Ethics approval was obtained from the Ethics Committee of the University of the Western Cape (HS/17/5/12, 24/07/2017; BM18/4/8, 08/06/2018).

2.7. Data Evaluation and Analysis

Trained student researchers graded and moderated the completed questionnaires using a structured memorandum. An independent research assistant captured the data on an Excel spreadsheet. A score of 50% in each knowledge subsection and skills section of the questionnaire indicated a pass in alignment with the school and university's grading system [22,25]. Statistical analyses were conducted using IBM Statistical Package for Social Sciences (SPSS) version 26. One-way between-groups ANOVA with planned comparisons was used to compare the effect of traditional and integrated curricula on participants' knowledge and skills. Participants' mean scores were compared to the average score of 50% using one-sample *t*-test to determine the pass rate. Linear regression analysis was used to determine the effect of participants' demographics on knowledge and skills mean scores. Cronbach's alpha was calculated to quantify the questionnaire's reliability.

3. Results

3.1. Participants' Demographics

A total of 142 final year pharmacy students participated in the study in three different cohorts between 2017 and 2019 based on their exposure to a fragmented or an integrated MCH curriculum. The results in Table 3 showed that 96% of the participants were between 20 and 30 years old, and 69% were female (98). Overall, thirteen participants (9%) were parents, while less than half of the participants (42%) did a locum.

Table 7.3 Demographic data of study participants for the 2017, 2018 and 2019 cohorts.

	2017 ***n* = 54 (%)**	**2018** ***n* = 41 (%)**	**2019** ***n* = 47 (%)**	**Total** ***n* = 142 (%)**
Age (in years)				
20 to 30	53 (98)	39 (95)	44 (94)	136 (96)
31 to 40	1 (2)	2 (5)	3 (6)	6 (4)
Gender				
Female	34 (63)	28 (68)	36 (77)	98 (69)
Male	20 (37)	13 (32)	11 (23)	44 (31)
Parenting status				
Have children	8 (15)	4 (10)	1 (2)	13 (9)
No children	46 (85)	37 (90)	46 (98)	129 (91)
Locum experience (in years)				
None	22 (41)	25 (61)	35(74)	82 (58)
1 to 2	26 (48)	16 (39)	11 (24)	53 (37)
>2	6 (11)	-	1(2)	7 (5)

3.2. Participants' Knowledge and Skills Assessment

As seen in Figure 1, the 2019 cohort obtained the highest mean score (70.7%, SD = 13.6) and scored consistently higher in all the MCH components than the two cohorts exposed to the traditional curriculum. The highest mean scores across the three cohorts were observed in the reproductive and sexual health components, while the lowest was recorded in the infant growth assessment skills components.

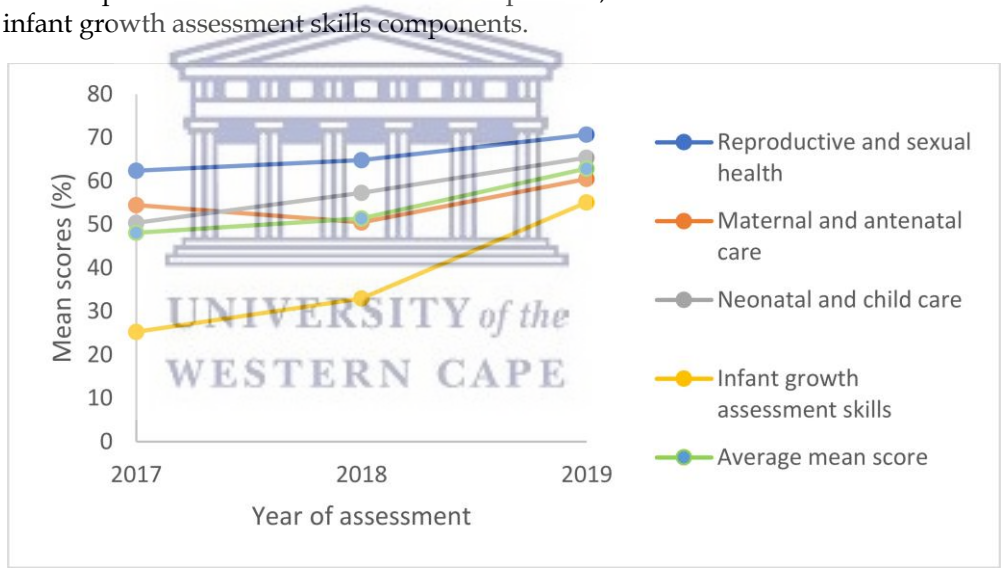

Figure 7.1 A plot of participants' mean scores in the three assessments shows that the highest scores were obtained in the 2019 assessment.

In Table 4, participants' mean scores were compared with the pass mark of 50%. The reproductive and sexual health components remained the strongest for all three cohorts, and the mean scores obtained were significantly ($p \leq 0.05$) above the pass mark. On the contrary, none of the cohorts scored a significant average pass mark in the infant growth assessment skills components. Overall, a significant average mean score was observed in the 2019 assessment. The Cronbach's Alpha A test of the reliability of the questionnaire was 0.739.

Table 7.4 Participants' mean scores in the three assessments in percentage compared to the university's stipulated pass mark of 50%.

	2017 Cohort (*n* = 54)	**2018 Cohort (*n* = 41)**	**2019 Cohort (*n* = 47)**
MCH Component	Mean (SD) [1] MD [2], *p*-value [3]	Mean (SD) MD, *p*-value	Mean (SD) MD, *p*-value
Reproductive and sexual health	62.4 (15.9) 12.4, 0.000	64.8 (15.5) 14.8, 0.000	70.7 (13.6) 20.7, 0.000
Maternal and antenatal care	54.5 (17.6) 4.5, 0.07	50.5 (16.4) 0.5, 0.8	60.5 (18.8) 10.5, 0.000
Neonatal and child care	50.4 (20.6) 0.4, 0.88	57.3 (18.8) 7.3, 0.000	65.4 (18.6) 15.4, 0.000
Infant growth assessment skills	25.3 (20.6) −24.7, 0.000	33.0 (24.9) −17.0, 0.000	55.1 (25.9) 5.1, 0.2
Average mean score	48.1 (14.3) −1.9, 0.35	51.4 (13.9) 1.4, 0.5	62.9 (13.7) 12.9, 0.000
Cronbach's Alpha A test ($n = 4$) [4]	0.739		

[1] Standard deviation, [2] Mean Difference—the difference between the mean scores obtained in the assessment and the university's stipulated pass mark of 50%, [3] Significant at $p \leq 0.05$, [4] Number of items analysed.

3.3. Comparison of Participants' Mean Scores in 2019 vs. 2017 and 2018 Assessments

In Table 5, one-way between-groups ANOVA with post hoc test compared participants' mean scores in the traditional and integrated curricula. The results showed a statistically significant difference in participants' mean scores between the 2019 and 2018 cohorts in the maternal and antenatal care components (p = 0.000, MD = 10). However, significant differences were observed in the mean scores of 2019 and 2017 cohorts in the reproductive and sexual health (p = 0.007, MD = 8.3) and neonatal and child care components (p = 0.000, MD = 15). Significant differences were observed between the integrated curriculum and traditional curriculum (2018 and 2017) in the infant growth assessment skills components (p = 0.000; MD 2018 = 22, MD 2017 = 29.8) and the average mean scores of participants (p = 0.000; MD 2018 = 11.5, MD 2017 = 14.8).

Table 7.5 Comparing participants' mean scores in the three assessments.

MCH Component	**Year Compared**	**Mean Difference (MD) [1] %**	***p*-Value [2]**
Reproductive and sexual health	2019 to 2018	5.9	0.069
	2019 to 2017	8.3	0.007
	2018 to 2017	2.4	0.454
Maternal and antenatal care	2019 to 2018	10.0	0.009
	2019 to 2017	6.1	0.089
	2018 to 2017	−4.0	0.283
Neonatal and child care	2019 to 2018	8.1	0.054
	2019 to 2017	15.0	0.000
	2018 to 2017	6.9	0.088
Infant growth assessment skills	2019 to 2018	22.0	0.000
	2019 to 2017	29.8	0.000
	2018 to 2017	6.9	0.088
Average mean scores	2019 to 2018	11.5	0.000
	2019 to 2017	14.8	0.000
	2018 to 2017	3.3	0.265

[1] Mean Difference is the difference between the mean scores obtained in two assessments, [2] Significant at ≤ 0.05.

No statistically significant differences were observed between the mean scores of participants exposed to the traditional curriculum in 2018 and 2017 in all the MCH components and the average mean score.

3.4. Effect of Participants' Demographic Data on Knowledge and Skills Scores

Linear regression analysis was used to identify the statistically significant effect of participants' demographic data on knowledge and skills mean scores in the three assessments (Table 6). Participants aged 20–30 years were associated with a lower score of 47% (β = −47.4) in the infant growth assessment skills section than the older students (31–40 years) in the 2017 assessment. In the 2018 assessment, being female was associated with a higher mean score of 11% in maternal and antenatal care than being male.

Table 7.6 Effects of participants' demographic variables on knowledge and skills mean scores.

Year of Assessment	MCH Component	Variable	Unstandardised Coefficients		
			B [1]	Standard error	*p*-value [2]
2017	Infant growth assessment skills	(Constant)	63.7	20.9	0.004
		Age (20–30 years)	−47.4	20.6	0.030
2018	Maternal and antenatal care	(Constant)	78.8	13.4	0.000
		Female	11.0	5.1	0.04
	Average total score	(Constant)	68.6	11.9	0.000
		Female	9.2	4.5	0.049
2019	Maternal and antenatal care	(Constant)	61.8	19.2	0.003
		Age (20–30 years)	−32.6	13.3	0.019
	Neonatal and child care	(Constant)	72.1	18.4	0.000
		Age (20–30 years)	−35.5	12.8	0.008
	Average total score	(Constant)	78.7	13.2	0.000
		Age (20–30 years)	−27.5	9.2	0.004

[1] B column contains the unstandardised beta coefficients that depict the magnitude and direction of the effect on the outcome variable. [2] *p*-value ≤ 0.05; then, that variable has a significant association with the outcome variable.

Similar to the 2017 assessment, participants who were 20–30 years old were associated with lower marks by 32% in maternal and antenatal care (β = −32.6) and 35% in neonatal and child care (β = −35.5) in the 2019 assessment. In addition, the same age range was associated with reducing the average mean score by 27.5% (β = −27.5). The multicollinearity of the demographic variables was not assessed, since that was not the focus of the study. Locum experience and parenting status did not affect participants' knowledge and skills.

4. Discussion

Changing from a traditional to an integrated curriculum was advocated for medical and health care professional education over the years because it is student-centred and can build competence by enhancing learning, knowledge retention, and application [20,33,34]. Koster et al. opined that for a competency-based curriculum to be achieved, competencies such as knowledge, skills, and behaviour relevant to a professional situation such as MCH should be integrated [18]. Zaman and Rauf demonstrated the advantages of integrating the MCH components in a medical curriculum in Pakistan [20]. Egieyeh et al. arrived at the same conclusion in a similar study of a pharmacy curriculum in South Africa [22]. This study further highlighted the knowledge and skills gains of an integrated MCH pharmacy curriculum over a traditional one through comparative evaluation between different cohorts, which was the first accomplished in South Africa.

4.1. Participants' Knowledge and Skills Assessment

Although statistical significance was not observed in participants' mean scores in all the MCH components between the integrated and traditional curriculum (2018 and 2017), the mean scores recorded for the 2019 cohort were higher than that of the 2018 and 2017 cohorts. The 2019 cohort also had the highest mean differences and significant average mean score, which showed that integrating the MCH contents in the curriculum enhanced the knowledge and skills of the 2019 final year pharmacy students. Tsinopoulos et al. reported a similar result. The overall mean score of students exposed to an integrated curriculum in ophthalmology at a Greek medical school was higher than that of students exposed to a traditional teaching method [35]. A statistically significant difference in participants' mean scores was reported for one MCH component in the 2019 and 2018 cohorts. This may be attributed to improved teaching methods in 2018 compared to 2017. However, there was no significant difference in participants' performance between 2017 and 2018 in the traditional curriculum, indicating that the curriculum integration enhanced participants' performance.

The effect of longitudinal dispersion of curriculum content was highlighted in this study, as the result showed that the reproductive and sexual health component consistently recorded the highest mean score in each assessment, even in the traditional exposure. Competency was developed as students progressed through the curriculum because the content was taught across students' years of study and the product demonstrated practical and experiential learning activities [18,22]. This provides evidence for the readiness of pharmacy graduates to provide reproductive and sexual health care services as part of the preventive drivers of MCM [28]. The SAPC requires pharmacists to undergo and register appropriate supplementary training to provide comprehensive reproductive health services. However, the competencies gained from the undergraduate training would enable them to engage in multidisciplinary teams and conduct health education programmes about family planning options. These are important not only for first pregnancies but also to decrease the high rate of repeat pregnancies in adolescents [10,30,36–38]. In addition, active learning methods such as small group seminars in place of lectures, role plays, journal club presentations and practical workshops that received positive feedback from students in other curriculum integration studies may be adopted [28,35].

4.2. Effect of Participants' Demographic Data on Knowledge and Skills Scores

The effect of the integrated MCH curriculum may be weakened in this study, as most of the participants (96%) who were between 20 and 30 years old were associated with lower scores in maternal and antenatal care, neonatal and child care, and consequently, the average mean score. This may be attributed to the low number of participants with children (2%) since most parents would be eager to learn and retain MCH knowledge and skills, as research has shown that parental knowledge influences children's developmental outcomes [39].

4.3. Limitations and Recommendations

There are limitations to our study. Data collection was from one cohort in the integrated curriculum, while it was collected from two cohorts in the traditional curriculum. The synergistic effect of the two-year data may have reduced the difference observed between the two curriculum exposures. Since a convenience sampling method was used in the three assessments, the results may not be a true reflection of the competencies of the entire class. In addition, the 2019 cohort had two prior exposures to the questionnaire in their second-year pre and post-exposure assessments. The repeated exposures may have given them an edge over the 2017 and 2018 cohorts who completed the questionnaire once in their final year of study. As the assessments did not count for course grades, the participants' stakes were low, which may have affected their performance. Infant growth assessment skills were examined as a written assessment rather than the traditional objective structured

clinical examination or practical evaluation due to inadequate manpower. The assessment process may undermine the results of that section.

Clinical nurse practitioners traditionally offer MCH at the primary care level. Increased multidisciplinary training would develop the competencies of entry-level graduates towards team-based care for South Africa's decentralised district-based primary care, which is crucial for health system strengthening [40].

Further research to assess practising pharmacists' MCH knowledge, attitude, and practices in South Africa should be carried out to inform the introduction of a continuing professional development programme.

5. Conclusions

The integration of the MCH content in the curriculum enhanced students' knowledge significantly. This supports the clamour for the training of health care professionals who are fit for purpose and able to meet the healthcare needs of the community they serve. To ensure adequate knowledge and skills acquisition and retention, active learning strategies, longitudinal dispersion of curriculum content across a student's years of study, interprofessional collaboration and avenues for work-based learning are vital.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/pharmacy10030062/s1, Questionnaire file.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the participants to publish this paper.

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References

1. World Health Organization. Trends in Maternal Mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. 2019. Available online: https://creativecommons.org/licenses/by-nc-sa/3.0/igo (accessed on 23 January 2022).
2. South African National Department of Health. *South African Maternal, Perinatal, and Neonatal Health Policy*; South African National Department of Health: Pretoria, South Africa, 2021.
3. Leung, H.Y.; Saini, B.; Ritchie, H.E. Medications and Pregnancy: The Role of Community Pharmacists—A Descriptive Study. *PLoS ONE* **2018**, *13*, e0195101. [CrossRef] [PubMed]
4. Ayele, A.A.; Islam, M.S.; Cosh, S.; East, L. Involvement and Practice of Community Pharmacists in Maternal and Child Health Services: A Systematic Review. *Res. Soc. Adm. Pharm.* **2021**, *17*, 643–652. [CrossRef]
5. Bains, S.; Kitutu, F.E.; Rahhal, A.; Abu Samaha, R.; Wilby, K.J.; Rowe, H. Comparison of Pharmacist Knowledge, Perceptions and Training Opportunities Regarding Maternal-Fetal Medicine in Canada, Qatar and Uganda. *Can. Pharm. J./Rev. Pharm. Can.* **2014**, *147*, 345–351. [CrossRef] [PubMed]
6. International Conference on Primary Health Care. Declaration of Alma-Ata. *WHO Chron.* **1978**, *32*, 428–430.
7. van Huyssteen, M.; Bheekie, A. Embedding Relevance in Pharmacy Training: A Case Study from South Africa. *Pharm. Educ.* **2015**, *15*, 270–274.

8. National Planning Commission: National Development Plan Vision 2030. 2013. Available online: https://www.nationalplanningcommission.org.za/National_Development_Plan (accessed on 20 May 2022).
9. Tsuyuki, R.T.; Beahm, N.P.; Okada, H.; Al Hamarneh, Y.N. Pharmacists as Accessible Primary Health Care Providers: Review of the Evidence. *Can. Pharm. J. CPJ* **2018**, *151*, 4. [CrossRef] [PubMed]
10. Jonas, K. Teenage Pregnancy during COVID-19 Double Pandemic. Available online: https://www.theindependent.co.zw/2021/09/10/teenage-pregnancy-during-covid-19-double-pandemic/ (accessed on 15 December 2021).
11. Busch-Hallen, J.; Walters, D.; Rowe, S.; Chowdhury, A.; Arabi, M. Impact of COVID-19 on Maternal and Child Health. *Lancet Glob. Health* **2020**, *8*, e1257. [CrossRef]
12. Adelekan, T.; Mihretu, B.; Mapanga, W.; Nqeketo, S.; Chauke, L.; Dwane, Z.; Baldwin-Ragaven, L. Early Effects of the COVID-19 Pandemic on Family Planning Utilisation and Termination of Pregnancy Services in Gauteng, South Africa: March–April 2020. *Wits J. Clin. Med.* **2020**, *2*, 145–152. [CrossRef]
13. World Health Organization. At Least 80 Million Children under One at Risk of Diseases Such as Diphtheria, Measles and Polio as COVID-19 Disrupts Routine Vaccination Efforts, Warn Gavi, WHO and UNICEF. Available online: https://www.who.int/news/item/22-05-2020-at-least-80-million-children-under-one-at-risk-of-diseases-such-as-diphtheria-measles-and-polio-as-covid-19-disrupts-routine-vaccination-efforts-warn-gavi-who-and-unicef (accessed on 3 June 2021).
14. Kotlar, B.; Gerson, E.; Petrillo, S.; Langer, A.; Tiemeier, H. The Impact of the COVID-19 Pandemic on Maternal and Perinatal Health: A Scoping Review. *Reprod. Health* **2021**, *18*, 10. [CrossRef]
15. Faduyile, T.; Oparah, A.C.; Oreagba, I.A. Potentials of Community Pharmacists to Improve Maternal, Newborn and Child Health. *West Afr. J. Pharm.* **2012**, *23*, 27–33.
16. Albassam, A.; Awad, A. Community Pharmacists' Services for Women during Pregnancy and Breast Feeding in Kuwait: A Cross-Sectional Study. *BMJ Open* **2018**, *8*, e018980. [CrossRef]
17. Grincevic˘iene˙, Š.; Kubiliene˙, L.; Ivanauskas, K.; Dra¸sutiene˙, G.S.; Ramašauskaite˙, D.; Grincevic˘ius, J.; Bernatoniene˙, J.; Savickas, A. Experiences of Community Pharmacists Advising Pregnant Women. *Int. J. Clin. Pharm.* **2015**, *37*, 636–644. [CrossRef]
18. Koster, A.; Schalekamp, T.; Meijerman, I. Implementation of Competency-Based Pharmacy Education (CBPE). *Pharmacy* **2017**, *5*, 10. [CrossRef]
19. Pearson, M.L.; Hubball, H.T. Curricular Integration in Pharmacy Education. *Am. J. Pharm. Educ.* **2012**, *76*, 204. [CrossRef] [PubMed]
20. Zaman, I.F.; Rauf, A. Working toward Decreasing Infant Mortality in Developing Countries through Change in the Medical Curriculum. *Asia Pac. Fam. Med.* **2011**, *10*, 11. [CrossRef]
21. Case, R. The Anatomy of Curricular Integration. *Can. J. Educ./Rev. Can. l'éduc.* **1991**, *16*, 215. [CrossRef]
22. Egieyeh, E.O.; Bheekie, A.; van Huyssteen, M.; Coetzee, R. Development and Implementation of an Integrated Framework for Undergraduate Pharmacy Training in Maternal and Child Health at a South African University. *Pharmacy* **2021**, *9*, 163. [CrossRef]
23. Academy of Science of South Africa (ASSAf). *Reconceptualising Health Professions Education in South Africa*; Academy of Science of South Africa: Pretoria, South Africa, 2018. [CrossRef]
24. van Heerden, B. Effectively Addressing the Health Needs of South Africa's Population: The Role of Health Professions Education in the 21st Century. *S. Afr. Med. J.* **2013**, *103*, 21–22. [CrossRef]
25. Egieyeh, E.; Van Huyssteen, M.; Coetzee, R.; Bheekie, A. Evaluating Pharmacy Students' Knowledge and Skills in Reproductive, Maternal, Newborn and Child Health Care at a South African University. *BMC Med. Educ.* **2021**, *21*, 34. [CrossRef]
26. The National Department of Health. *South Africa: Essential Drugs Programme. Primary Healthcare Standard Treatment Guideline and Essential Medicine List*, 7th ed; South African National Department of Health: Pretoria, South Africa, 2020.
27. Taylor, D.C.M.; Hamdy, H. Adult Learning Theories: Implications for Learning and Teaching in Medical Education: AMEE Guide No. 83. *Med. Teach.* **2013**, *35*, e1561–e1572. [CrossRef]
28. El-Ibiary, S.Y.; Azizoddin, A.; Petrossian, L.; Gurney, M.K. Implementation and Evaluation of a Women's Reproductive Health Pharmacy Elective. *Curr. Pharm. Teach. Learn.* **2018**, *10*, 1087–1096. [CrossRef] [PubMed]
29. Bac, M.; Bergh, A.M.; Etsane, M.E.; Hugo, J. Medical Education and the Quality Improvement Spiral: A Case Study from Mpumalanga, South Africa. *Afr. J. Prim. Health Care Fam. Med.* **2015**, *7*, a738. [CrossRef] [PubMed]
30. South African Pharmacy Council. *Good Pharmacy Practice Manual and Associated SAPC Rules Good Pharmacy Practice in South Africa*; South African Pharmacy Council: Pretoria, South Africa, 2017; p. 194. Available online: http://www.pharmcouncil.co.za/G_PublicationsD.asp (accessed on 29 July 2021).
31. International Pharmaceutical Federation (FIP). *FIP Statement of Policy on the Effective Utilisation of Pharmacists in Improving Maternal, Newborn and Child Health (MNCH)*; International Pharmaceutical Federation: The Hague, The Netherlands, 2013; Available online: https://www.fip.org/files/fip/publications/FIP_Statement_of_Policy_MNCH_2013_Final.pdf (accessed on 10 September 2021).
32. Bains, S.; Rowe, H.; Wilby, K.J. Pharmacists and Maternal-Fetal Medicine: Development of a Tool to Characterize Knowledge and Current Clinical Practice. *J. Matern. Neonatal Med.* **2013**, *27*, 753–755. [CrossRef] [PubMed]
33. Buckner, A.V.; Ndjakani, Y.D.; Banks, B.; Blumenthal, D.S. Using Service-Learning to Teach Community Health: The Morehouse School of Medicine Community Health Course. *Acad. Med.* **2010**, *85*, 1645–1651. [CrossRef]
34. Ryan, T.J.; Grimes, T.; Henman, M.C.; Sheachnasaigh, E.N.; O'Dwyer, M.; Roche, C.; Ryder, S.A.; Sasse, A.; Walsh, J.J.; D'Arcy, D.M. Design and Implementation of an Integrated Competency-Focused Pharmacy Programme: A Case Report. *Pharmacy* **2019**, *7*, 121. [CrossRef]

35. Tsinopoulos, I.T.; Tsaousis, K.; Symeonidis, C.; Chalvatzis, N.; Tzamalis, A.; Lamprogiannis, L.; Dimitrakos, S.A.; Mataftsi, A. Contribution of Integrated Teaching in the Improvement of an Undergraduate Ophthalmology Curriculum. *Adv. Med. Educ. Pract.* **2014**, *5*, 433. [CrossRef]
36. Sama, C.B.; Ngasa, S.N.; Dzekem, B.S.; Choukem, S.P. Prevalence, Predictors and Adverse Outcomes of Adolescent Pregnancy in Sub-Saharan Africa: A Protocol of a Systematic Review. *Syst. Rev.* **2017**, *6*, 247. [CrossRef]
37. Govender, D.; Naidoo, S.; Taylor, M. Scoping Review of Risk Factors of and Interventions for Adolescent Repeat Pregnancies: A Public Health Perspective. *Afr. J. Prim. Health Care Fam. Med.* **2018**, *10*, a1685. [CrossRef]
38. Smith, G.C.S.; Pell, J.P. Teenage Pregnancy and Risk of Adverse Perinatal Outcomes Associated with First and Second Births: Population Based Retrospective Cohort Study. *Br. Med. J.* **2001**, *323*, 476–479. [CrossRef]
39. Ertem, I.O.; Atay, G.; Dogan, D.G.; Bayhan, A.; Bingoler, B.E.; Gok, C.G.; Ozbas, S.; Haznedaroglu, D.; Isikli, S. Mothers' Knowledge of Young Child Development in a Developing Country. *Child Care Health Dev.* **2007**, *33*, 728–737. [CrossRef]
40. Bheekie, A.; Bradley, H. Re-Engineering of South Africa's Primary Health Care System: Where Is the Pharmacist? *S. Afr. Fam. Pract.* **2016**, *58*, 242–248. [CrossRef]

CHAPTER EIGHT: General discussion

8.1 Introduction

This chapter briefly combines and synthesises significant results from chapters five, six, and seven, although each contains a detailed discussion. The discussion focuses on the effect of teaching and learning methods on students' knowledge and skills in maternal and child health (MCH).

8.2 Evaluation of MCH knowledge and skills from a traditional curriculum (Phase 1)

In 2017, final-year undergraduate pharmacy students exposed to a traditional curriculum participated in a baseline assessment to evaluate their MCH knowledge and skills using a questionnaire survey (E. Egieyeh *et al.*, 2021).

Results from chapter five showed a poor reflection of participants' knowledge and skills in MCH. Only seven (13%) of the 54 participants scored above 50%, the university pass mark in each questionnaire section. On calculating the individual mean scores of participants, less than 50% of the participants [24 (44%)] scored above average. Although all other MCH components had above-average mean scores except in infant growth assessment skills, where there was no planned curriculum exposure (62.4% in reproductive and sexual health, 54.5% in maternal and antenatal care, 50.4% in neonatal and child care, and 25.3% in infant growth assessment skills), when compared to the 50% pass mark, only the reproductive and sexual health component had a statistically significant difference (p = 0. 000). The reproductive and sexual health component also had the highest mean score (62.4%), which may be related to the longitudinal dispersion of the topic in the second and fourth years of study. Relatedly, the knowledge mean scores of pharmacists who participated in a study comparing the knowledge, perceptions and training opportunities regarding maternal-foetal medicine in Canada, Qatar and Uganda were 62.9, 53.3, and 57.7%, respectively (Bains *et al.*, 2014). Bains et al. posited that the mean scores were low because of the delicate nature of the practice area. Higher mean scores would indicate competence which may help to eradicate the knowledge gap observed in practice.

In South Africa, MCM is one of the quadruple disease burdens (Hofman and Madhi, 2020). The shortage of healthcare professionals in the MCH workforce further compounds the situation (Bheekie and Bradley, 2016). With the required knowledge and skills to render quality services to these vulnerable groups of patients, pharmacy graduates can provide adequate services to patients (Bains *et al.*, 2014). Also, undergraduate students can provide service-learning support at healthcare facilities to alleviate the shortage of healthcare workers (Bheekie and Bradley, 2016).

At the time of writing this thesis, no study has evaluated the MCH curriculum in health professional education in Africa. However, some studies have reviewed the undergraduate curriculum of specific components of MCH, such as neonatal care (Kritzinger and Louw, 2003; Chimhuya *et al.*, 2018). Consequently, a recommendation was made to review and integrate the MCH content at the School of Pharmacy.

8.3 Development and implementation of an integrated framework in MCH (Phase 2)

Case R (1991) defined integration as the "intentional uniting or meshing of discrete elements or features of a planned educational experience" (Case, 1991). Curriculum integration is a plan to ensure that educational experiences are comprehensible, applicable, engaging, connect diverse disciplines and aid higher-order learning (Pearson and Hubball, 2012). Content integration entails linking the perceptions endorsed within and among various disciplines or subject areas (Case, 1991).

The analysis of variance (ANOVA) and post hoc tests chapter showed that developing and implementing an integrated framework in MCH for undergraduate training across the four years of study enhanced students' learning. Students performed significantly above the baseline and the pass mark of 50% in the post-intervention assessment in the second and fourth-year assessments. The result was similar to that observed by Zaman and Rauf (2011) following a post-intervention assessment after students were exposed to an integrated MCH module in the second year of study (Zaman and Rauf, 2011). Tsinopoulos et al. also showed that the scores obtained by students increased significantly (P = 0.001) post-exposure to integrated teaching in anatomy. It was (6.17±1.67, mean ± standard deviation) higher than students exposed to traditional teaching (5.52±2.20). Also, more students indicated satisfaction with the integrated teaching method (Tsinopoulos *et al.*, 2014).

Significant loss of knowledge and skills in all MCH components was observed in the fourth-year assessment, two years later, except in the reproductive and sexual health component (E. O. Egieyeh *et al.*, 2021). The non-use or non-practice of the knowledge and skills leading to long retention intervals may be responsible for the loss of knowledge and skills. Custers affirmed that the retention of basic science knowledge from medical school was better than general science knowledge depending on the frequency of use or reinforcement (Custers, 2010). As a result, the reproductive and sexual health component recorded an insignificant result due to the longitudinal dispersion of the content in the second and fourth years of study. This shows the readiness of our graduates to offer contraception services which is a necessity in South Africa based on the high incidence of teenage pregnancy recorded in the country.

8.4 Comparative evaluation of the traditional and integrated curriculum (Phase 3)

A change from a traditional to an integrated curriculum was advocated for medical and health care professionals' education over the years because of the view that it is student-centred and it can build competence by enhancing students learning, knowledge retention, and application (Buckner *et al.*, 2010; Zaman and Rauf, 2011; Ryan *et al.*, 2019). Koster et al. opined that for a competency-based curriculum to be achieved, competencies such as knowledge, skills, and behaviour relevant to a professional situation such as MCH should be integrated (Koster, Schalekamp and Meijerman, 2017). Zaman and Rauf demonstrated the advantages of integrating the MCH components in a medical curriculum in Pakistan (Zaman and Rauf, 2011). Egieyeh et al. arrived at the same conclusion in a similar study of a pharmacy curriculum in South Africa in the phase two study of the thesis (E. O. Egieyeh *et al.*, 2021). This study further highlighted the knowledge and skills gains of an integrated MCH pharmacy curriculum over a traditional one through comparative evaluation between different cohorts, the first to be accomplished in South Africa.

In chapter seven, statistically significant differences were observed in the average mean scores of participants exposed to an integrated MCH curriculum in 2019 (cohort 4) and those exposed to a traditional one in 2018 (cohort 3) and 2017 (cohort 2). More specifically the integrated curriculum cohort 4 outperformed the traditional curriculum cohort 2 in the sections on reproductive and sexual health ($p = 0.007$, MD = 8.3), neonatal and child care ($p = 0.000$, MD = 15) and the infant growth assessment skills components ($p = 0.000$, MD = 29.8). In addition, statistically significant differences were observed between the mean scores of the participants exposed to an integrated

MCH curriculum in 2019 (cohort 4) and those exposed to a traditional one in 2018 (cohort 3) in the maternal and antenatal care (p = 0.000, MD = 10) and the infant growth assessment skills components (p = 0.000, MD = 22.0). No statistically significant differences were observed between the mean scores of participants exposed to the traditional curriculum in 2018 and 2017 in all the MCH components.

The result showed that integrating the MCH contents in the curriculum enhanced the knowledge and skills of the 2019 final year pharmacy students when compared to the 2018 and 2017 cohorts. Tsinopoulos et al. reported a similar result where the overall mean score of students exposed to an integrated curriculum in ophthalmology at a Greek medical school was higher than that of students exposed to a traditional teaching method (Tsinopoulos *et al.*, 2014). Further, the mean differences recorded in the 2019 assessment (p = 0.000) were higher and statistically significant in all the MCH components compared to the 2017 and 2018 cohorts.

The positive effect of longitudinal dispersion of curriculum content was highlighted in this study. The results showed that the reproductive and sexual health component consistently recorded the highest mean score in each assessment, including the traditional curriculum assessment. The reproductive and sexual health content included the contraceptive products demonstration practical and experiential learning activities. The content was dispersed across the second and fourth years of study, which helped the students develop competence. (Koster, Schalekamp and Meijerman, 2017; E. O. Egieyeh *et al.*, 2021). The result is evidence of the readiness of pharmacy graduates to provide reproductive and sexual health care services as part of the preventive drivers of MCM (El-Ibiary *et al.*, 2018). The competencies gained from the undergraduate training would enable them to engage in a multidisciplinary team to conduct health education programmes about family planning options. These competencies are essential for preventing first pregnancies in adolescents and to decrease the high rate of repeat pregnancies (Smith and Pell, 2001; Sama *et al.*, 2017; Govender, Naidoo and Taylor, 2018; Jonas, 2021). However, currently, pharmacists must register appropriate supplementary training with the SAPC to provide comprehensive reproductive health (South African Pharmacy Council, 2017, 2021).

8.5 References

Bains, S. *et al.* (2014). Comparison of pharmacist knowledge, perceptions and training opportunities regarding maternal-fetal medicine in Canada, Qatar and Uganda. *Canadian pharmacists journal: CPJ = Revue des pharmaciens du Canada: RPC*, 147(6), pp. 345–51. Doi: 10.1177/1715163514552558.

Bheekie, A. and Bradley, H. (2016). Re-engineering of South Africa's primary health care system: Where is the pharmacist? *South African Family Practice*, 58(6), pp. 242–248. Doi: 10.1080/20786190.2016.1186365.

Buckner, A. V *et al.* (2010). Using Service-Learning to Teach Community Health: The Morehouse School of Medicine Community Health Course. *Academic Medicine*, 85(10), pp. 1645–1651. Doi: 10.1097/ACM.0b013e3181f08348.

Case, R. (1991). The Anatomy of Curricular Integration. *Canadian Journal of Education / Revue canadienne de l'éducation*, 16(2), p. 215. Doi: 10.2307/1494974.

Chimhuya, S. *et al.* (2018). Development of a neonatal curriculum for medical students in Zimbabwe - A cross sectional survey. *BMC Medical Education*, 18(1), pp. 1–9. Doi: 10.1186/s12909-018-1194-2.

Custers, E. J. F. M. (2010). Long-term retention of basic science knowledge: A review study. *Advances in Health Sciences Education*, 15(1), pp. 109–128. Doi: 10.1007/s10459-008-9101-y.

Egieyeh, E. *et al.* (2021). Evaluating pharmacy students' knowledge and skills in reproductive, maternal, new-born and child health care at a South African university. *BMC Medical Education*, 21(1), pp. 1–16. Doi: 10.1186/s12909-020-02476-9.

Egieyeh, E. O. *et al.* (2021). Development and Implementation of an Integrated Framework for Undergraduate Pharmacy Training in Maternal and Child Health at a South African University. *Pharmacy*, 9(4), p. 163. Doi: 10.3390/pharmacy9040163.

El-Ibiary, S. Y. *et al.* (2018). Implementation and evaluation of a women's reproductive health pharmacy elective. *Currents in Pharmacy Teaching and Learning*, 10(8), pp. 1087–1096. Doi: 10.1016/j.cptl.2018.05.007.

Govender, D., Naidoo, S. and Taylor, M. (2018). Scoping review of risk factors of and interventions for adolescent repeat pregnancies: A public health perspective. *African Journal of Primary Health Care and Family Medicine*, 10(1), p. 10. Doi: 10.4102/phcfm.v10i1.1685.

Hofman, K. and Madhi, S. (2020). The unanticipated costs of COVID-19 to South Africa's quadruple disease burden. *South African Medical Journal*, 110(8), pp. 698–699. Doi: 10.7196/SAMJ.2020.v110i8.15125.

Jonas, K. (2021). *Teenage pregnancy during Covid-19 double pandemic*. *SAMRC*. Available at: https://www.theindependent.co.zw/2021/09/10/teenage-pregnancy-during-covid-19-double-pandemic/.

Koster, A., Schalekamp, T. and Meijerman, I. (2017). Implementation of Competency-Based Pharmacy Education (CBPE). *Pharmacy*, 5(4), p. 10. Doi: 10.3390/pharmacy5010010.

Kritzinger, A. and Louw, B. (2003). Clinical training of undergraduate communication pathology students in neonatal assessment and neonate-caregiver interaction in South Africa. *The South African journal of communication disorders. Die Suid-Afrikaanse tydskrif vir Kommunikasieafwykings*, 50, pp. 5–14. Doi: 10.4102/sajcd.v50i1.210.

Pearson, M. L. and Hubball, H. T. (2012). Curricular integration in pharmacy education. in *American Journal of Pharmaceutical Education*. American Association of Colleges of Pharmacy. Doi: 10.5688/ajpe7610204.

Ryan, T. J. *et al.* (2019). Design and Implementation of an Integrated Competency-Focused Pharmacy Programme: A Case Report. *Pharmacy*, 7(3), p. 121. Doi: 10.3390/pharmacy7030121.

Sama, C. B. *et al.* (2017). Prevalence, predictors and adverse outcomes of adolescent pregnancy in sub-Saharan Africa: A protocol of a systematic review. *Systematic Reviews*, 6(1). Doi: 10.1186/s13643-017-0650-0.

Smith, G. C. S. and Pell, J. P. (2001). Teenage pregnancy and risk of adverse perinatal outcomes associated with first and second births: Population based retrospective cohort study. *British Medical Journal*, 323(7311), pp. 476–479. Doi: 10.1136/bmj.323.7311.476.

South African Pharmacy Council. (2017). Good Pharmacy Practice in South Africa. *South African Pharmacy Council*, p. 194. Available at: http://www.pharmcouncil.co.za/G_PublicationsD.asp.

South African Pharmacy Council. (2021). *Board notice 180 of 2021 board notice no __ of 2021 the South African Pharmacy Council pharmacist providing family planning services (reproductive health services)*. Available at: https://www.pharmcouncil.co.za/Legislation_Proposed (Accessed: 10 June 2022).

Tsinopoulos, I. T. *et al.* (2014). Contribution of integrated teaching in the improvement of an undergraduate ophthalmology curriculum. *Advances in Medical Education and Practice*, 5, p. 433. Doi: 10.2147/AMEP.S71759.

Zaman, I. F. and Rauf, A. (2011). Working toward Decreasing Infant Mortality in Developing Countries through Change in the Medical Curriculum. *Asia Pacific Family Medicine*, 10(1), pp. 1–9. Doi: 10.1186/1447-056X-10-11.

CHAPTER NINE: Overall conclusion

9.1 Introduction

This chapter aims to reconcile the general findings from chapters five, six and seven of this thesis with the objectives set out in chapter one. It also presents the study's limitations and recommendations that may further enhance pharmacists' role in maternal and child health (MCH) and the acquisition of the required knowledge and skills in undergraduate training programmes.

9.2 Study objectives accomplished

In the study of the knowledge and skills of undergraduate pharmacy students in MCH, all the objectives set out in chapter one was successfully achieved. The objectives included:

1. To evaluate the MCH knowledge and skills, and analyse the curriculum content exposure of final year pharmacy students exposed to a traditional curriculum.

2. To develop and implement a comprehensive and integrated MCH framework for undergraduate training at the School of Pharmacy (SOP), University of the Western Cape (UWC) based on the International Pharmaceutical Federation (FIP) policy statement on the effective utilisation of pharmacists in improving MNCH, and the South African Pharmacy Council (SAPC) Good Pharmacy Practice (GPP) on MCH (International Pharmaceutical Federation (FIP), 2013; South African Pharmacy Council, 2017).

3. To evaluate and compare the MCH knowledge and skills of a cohort of final year students exposed to the integrated MCH curriculum to two cohorts exposed to a traditional curriculum.

9.3 Overall conclusion

An objective of the National Development Plan 2030 and the Academy of Science of South Africa is to train healthcare professionals who can meet the healthcare needs of their communities (National Planning Commission, 2013; Academy of Science of South Africa (ASSAf), 2018). To achieve this objective in MCH, the undergraduate curriculum must be adapted to address the priority healthcare needs of society and it should be integrated into its delivery. The basic idea for developing a framework for undergraduate training in this thesis was an intervention to review and integrate the curriculum based on the knowledge and skills gaps observed from the baseline

assessment of students exposed to a traditional curriculum. The framework was predicated on the FIP policy statement on the effective utilisation of pharmacists in improving maternal, newborn and child health, the SAPC GPP manual standards for MCH service provision, the MCH health workforce shortages and the Sustainable Development Goal (SDG) 3 targets for MCH (International Pharmaceutical Federation (FIP), 2013; World Health Organization, 2015; South African Pharmacy Council, 2017). MCH curriculum integration involved scaffolding of didactic lectures, skills practicals, primary healthcare facilities sessions and underserved community visits; to enhance student knowledge and skills acquisition and retention and promote preventive thinking. Students' performance improved post-intervention but declined significantly two years later in all the MCH components attributable to non-use or non-practice except in the reproductive and sexual health components longitudinally dispersed in the second and fourth years of study. Comparative evaluation of the traditional and integrated curriculum showed that students exposed to the integrated curriculum had higher mean scores in all the MCH components than those exposed to a traditional curriculum. The reproductive and sexual health component had the highest mean score in all the assessments undertaken by the students. In contrast, the infant growth assessment skills section had the least.

Developing and implementing a framework for an integrated MCH curriculum enhanced student knowledge and skills acquisition and retention. The framework included an instructional orientation session outlining the project's purpose. The lecturer established the link between the different components of the framework and the continuum of care in MCH. The importance of assessing students' baseline knowledge and skills to identify the level at which lecture content should be pitched was identified in this thesis. It was deduced that lecture content must be above students' baseline knowledge to aid learning. Including active learning strategies such as case simulations, contraceptive demonstration practical and infant growth assessment skills practical will aid student learning. In addition, longitudinal dispersion of MCH curriculum content across the years of study aided learning and retention. On-campus didactic lectures and practicals were linked to real-life situations at health care facilities and underserved community engagement service-learning activities. The aim was to develop self-confidence, interprofessional skills, understanding of the health care system and the social determinants of health. Students were encouraged to identify and fill a healthcare delivery gap at the PHC facilities, thereby adding relevance to the service-learning activity.

9.4 Study Limitations

There were several limitations to the study. The study was a single-site study carried out at one pharmacy school in South Africa. However, the longitudinal nature of the study should be a benefit. A primary limitation was students' reluctance to participate in study assessments that do not contribute to their academic grades. Therefore, participants' stakes were low, which may have affected their performance and participation in the study, resulting in a dwindling number of participants recorded. Like most student-dependent studies, a convenience sampling method was employed. As a result, the results obtained from the study may not be a true reflection of the performance of the class. As an iterative study, data were collected yearly for three years during the presentation of the relevant modules, which delayed data analyses, thesis writing and completion of the programme. During the different phases of the study, the same data collection tool (questionnaire) was used repeatedly. Students may have become familiar with the questions. However, responses to the questions were not provided at any point in the study. Infant growth assessment skills were examined in a written assessment rather than the traditional objective structured clinical examination or practical evaluation due to inadequate human resources. As such, the result may not be a true reflection of the class performance, which may undermine the result from the section.

9.5 Recommendations

9.5.1 Recommendations for pharmacy education

- The integrated MCH framework should be evaluated by the SAPC for potential inclusion in the pharmacy curriculum at all pharmacy schools in South Africa.
- More active learning methods such as role-plays, journal club presentations, and practical workshops are suggested to strengthen students' knowledge and skills in MCH.
- Curriculum planners at pharmacy schools should embrace and support service-learning programmes that expose students to the socio-economic and health status of the local communities to promote preventive thinking, a goal of PHC.
- Collaborations between pharmacy schools and the healthcare system are necessary to strengthen the interdependence that is required to collectively address the country’s priority MCH concerns. By removing barriers between the two institutions the establishment of educational centres especially in MCH could be initiated.

- Working alongside clinical nurse practitioners who traditionally offer MCH services at the primary care level, multidisciplinary training at the clinic could strengthen the competencies of entry-level pharmacy graduates. Such graduates would form part of the team-based service provision which underpins South Africa's decentralised district-based primary health care system.
- More avenues for undergraduate pharmacy students to carry out work-based learning using their MCH knowledge and skills are essential to reinforce learning and retention.

9.5.2 Recommendations for research in pharmacy education

- Further studies on factors that may reinforce students' knowledge and skills in MCH and improve content integration are recommended.

9.5.3 Recommendations for pharmacy practice research

- A study on practising pharmacists' MCH knowledge, attitude and practices in South Africa is also suggested to inform the introduction of continuing professional development programmes.
- The South African Pharmacy Council should advocate for the role and training of pharmacists in MCH.
- Young graduates and undergraduates should be encouraged to embrace the supplemental training programmes required to provide reproductive and sexual health services and administer immunisations.

9.6 References

Academy of Science of South Africa (ASSAf). (2018). *Reconceptualising Health Professions Education in South Africa*. Doi: 10.17159/assaf.2018/0021.

International Pharmaceutical Federation (FIP). (2013). *FIP statement of policy on the effective utilization of pharmacists in improving maternal, newborn and child health (MNCH)*. Dublin. Available: https://www.fip.org/files/fip/publications/FIP_Statement_of_Policy_MNCH_2013_Final.pdf.

National Planning Commission. (2013). *National development plan vision 2030*.

South African Pharmacy Council. (2017). Good Pharmacy Practice in South Africa. *South African Pharmacy Council*, p. 194. Available at: http://www.pharmcouncil.co.za/G_PublicationsD.asp.

World Health Organization. (2015). *Health in 2015: from MDGs, Millennium Development Goals to SDGs, Sustainable Development Goals., World Health Organisation*. Doi: 978 92 4 156511 0.

APPENDICES

APPENDIX 1: International Pharmaceutical Federation (FIP) Summary of pharmacists' contributions in line with World Health Organization (WHO) top interventions in Maternal, Neonatal and Child Health (MNCH).

Stage	WHO maternal, new-born and child health interventions	Current Pharmacist contribution in line with the WHO suggested interventions to high-priority countries
Pre-pregnancy	Contraception	- Educate women on and supply various contraceptives options - Prescribe and/or initiate emergency contraception
Pregnancy	At least 4 antenatal visits	- Educate mothers on and supply vitamins and nutritional supplements, including folic acid and iron supplements - Promote cessation of alcohol and nicotine use - Evaluation of potential teratogenic medicines, and advice on alternative drug regimens if teratogenicity of current treatment is known or a reduction in risk is required.(e.g. in epilepsy)
	Prevention of mother-to-child disease transmission	- Obtain, store and dispense appropriate anti-retroviral - Promote and facilitate medication adherence - Educate communities and/or patients at high risk of disease transmission
	Intermittent preventive treatment of malaria for pregnant women	- Recommend drug therapy, dosages, and duration of therapy - Promote prevention and early treatment - Promote medication adherence - Supplying non-pharmacological products (e.g. insecticide-treated bed nets) - Educate communities at high risk
	Neonatal tetanus protection	Not addressed. Although pharmacists are usually not involved in neonatal tetanus protection, it is our belief that there is a high potential for pharmacists' involvement
Birth	Skilled attendant at birth	Make decisions regarding accessibility of critical medications in labour and delivery - Provide required sterile medical products during delivery - Support caregivers (e.g. midwives) through education on medicines and safe medication practices - Ensure safe and legal medicine use policies are in place in labour wards/ birth centres/ community services/ home birth
Postnatal	Postnatal visits for mother	- Identify women at risk of postpartum depression - Ensure guidelines and appropriate medication in place to manage sepsis (maternal and neonatal) and prevent maternal venous thromboembolism
	Early initiation of Breastfeeding	- Support breastfeeding (when replacement feeding is acceptable, feasible, affordable, sustainable and safe, avoidance of all breastfeeding by HIV-infected mothers is recommended)
Infancy	Exclusive breastfeeding (less than age 6 months)	- Assess pharmacokinetics and potential for medicine distribution into breast milk - Patient education on healthy diet and physical activity - Recommend non-pharmacological products to facilitate breastfeeding

		- Ensure guidelines and appropriate medication in place to manage mastitis and other breastfeeding complications
	Complementary breastfeeding (age 6-9 months)	- Breast-feeding support
	Immunization: Measles and DPT3	- Educate caregivers and parents on the importance of comprehensive vaccination (as per local protocols) Documentation of vaccination history - Independently administer vaccines - Provide immunisation clinics in pharmacies
	Vitamin A supplementation (two doses)	- Vitamin A supplementation is accessible through pharmacies
Childhood	Children sleeping under insecticide-treated nets	- Supply insecticide-treated bed nets
	Care seeking for Pneumonia	Not addressed Although pharmacists are usually not involved in care seeking for pneumonia, it is our belief that there is a high potential for pharmacists' involvement
	Antibiotics for Pneumonia	- Ensure no deficiencies in quality, purity or potency of medicinal products - Alter dosage forms to improve adherence and ease of administration
	Diarrhoea Treatment	Supply effective drug therapy (including access to oral rehydration salts and zinc therapy) - Ensure no deficiencies quality, purity or potency of medicinal products - Access to oral re-hydration salts
	Improved sanitation facilities	- Guide the public on the proper disposal of medications
	Improved drinking water	Not addressed Although pharmacists are usually not involved in improving drinking water, it is our belief that there is a high potential for pharmacists' involvement

APPENDIX 2: Information sheet, consent form and questionnaire for 2017 second-year undergraduate pharmacy students (Cohort 1).

Dear BPharm II Student

Information sheet for participation in research

Research title: The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape.

Background

High maternal and child mortality is one of the quadruple burdens of disease facing South Africa. The reduction in mortality rate between 2009 and 2015 falls short of the targets of the Millennium Development Goals (MDGs), and consequently the Sustainable Development Goals (SDGs). Most deaths are from preventable and curable causes.

A focus of the National Development Plan (NDP) is the reduction of maternal and child mortality. Pharmacists as part of the health workforce should be equipped with the relevant knowledge and skill required to contribute to the reduction.

Aim of study

The aim of this study is to develop a framework for an integrated training program in Maternal and Child Health (MCH) for undergraduate pharmacy students at University of the Western Cape (UWC).

Procedures

You are being asked to participate in this study because you are a BPharm II student of the School of Pharmacy, University of the Western Cape.

If you agree to participate in this study,

- You will be asked to complete a questionnaire on MCH as a baseline study. The questionnaire will be returned to the investigator(s) for analysis.
- If on analysis of participants' responses, a knowledge gap is identified, current curriculum content will be reviewed and updated. An intervention, a supplementary lecture in the form of a video will be made available to the BPharm II class.
- Subsequently, you will be asked to complete a questionnaire in a post-intervention study. The questionnaire will be returned to the investigator(s) for analysis.
- A 50% score in each aspect of MCH (section of the questionnaire) confers a pass mark.

The mark obtained may not contribute toward your academic achievement. It may be purely for research purpose.

Confidentiality

Your name will not be used on the questionnaire or other printed materials associated with the study. A unique ID will be allotted to each participant. Study materials will be kept in a secure location where only the senior investigators will have access to it.

Voluntary participation

Participation in this study is voluntary. Your decision to take part in the study or not will not affect your interaction with UWC and the School of Pharmacy in any way. You can choose to withdraw from the study at any time.

Risks

You would not be at risk for participating in this study.

Benefits

You will be providing important information that will help in improving curriculum content in MCH. This will ensure that pharmacy graduates from UWC SOP are competent to participate in this area of health care.

Costs

There will be no cost to you for participating in this study.

Questions

If you have any question(s), you may please speak to Mrs Elizabeth Egieyeh (0219592192, Office F12). If you are unsatisfied with the response given then please speak to anyone of the other programme co-ordinators:
Professor Angeni Bheekie: 0219592977, Office K6
Dr Mea van Huyssteen: 0219592864 Office F5
Dr Renier Coetzee: 0219593665, Office F6

Ethics approval

The University of the Western Cape Ethics Review Board and the Registrar has granted ethics approval.

If you have any comments or concerns about participation in this study, you should first talk with the researchers. If for some reason you do not wish to do this, you may contact the University of Western Cape Ethics Review Board, which is concerned with the protection of volunteers in research projects.

CONSENT FORM

Research title: The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape

I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

1. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.

2. I understand that the study will not affect my legal rights and the data collected will not be linked to me in any way and full confidentiality is guaranteed
3. It has been explained clearly to me that the study was approved by relevant ethics committee
4. I agree to take part in the above study.

Participant study number	Date	Signature of participant
Name of researcher	Date	Signature of researcher

Research title: The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape.

Unique ID:

A. PERSONAL INFORMATION (Write an X by the applicable option)

1. Age:
18-30
31-45

2. **Gender**:
Male
Female

3. Parental status:
Children
No Children

4. Student's first language:
Afrikaans
English
IsiXhosa
Other (please specify) _____

5. Exposure to family planning, maternal and child health other than that undertaken at the School's academic program:
Yes
No
If yes, please explain _____
_____

ALL QUESTIONS ARE ALLOTED ONE MARK EXCEPT OTHERWISE INDICATED

B. KNOWLEDGE ASSESSMENT

B1. REPRODUCTIVE/SEXUAL HEALTH

Circle the correct answer of Fill the blank spaces with the correct answer as applicable.

1. Which hormones are present in combined oral contraceptives?
    a. Estrogen and progestogen
    b. Testosterone and oxytocin
    c. Prolactin and thyroxin
    d. Prolactin and oxytocin

2. Combined oral contraceptives should be started
    a. Between day 1 and day 5 of the cycle
    b. At any time in the absence of pregnancy with additional precaution (barrier method) until 7 hormonal pills have been taken
    c. After day 5 of the cycle with additional precaution (barrier method) until 7 hormonal pills have been taken
    d. All of the above

3. Which of the following contraceptive methods' effectiveness relies on the client's ability to use them correctly?
    a. Vasectomy
    b. Condoms
    c. IUD
    d. Sub-dermal implant

4. Long acting reversible contraceptives (LARC) are defined as methods that require administration once in months or cycles. Which of the methods listed below fall within this definition?
    i. Copper IUD
    ii. Levonorgestrel releasing intrauterine system
    iii. Progestogen-only injectables
    iv. Sub-dermal progestogen implants
    a. All of the above
    b. None of the above

5. Emergency contraception is absolutely indicated after sexual intercourse in all of the following situations except
    a. Slipped or broken condom
    b. Two pills forgotten during the first 7 active pills
    c. > 2 weeks late for progestogen-only injections
    d. <2 weeks late for progestogen-only injections

6. The following information is important before emergency contraception is dispensed except one?
    a. Date of the last menstrual period
    b. <120 hours since the last episode of unprotected intercourse
    c. How many hours of rest observed
    d. Exclusion of pregnancy

7. Oral progestogen-only pills are
    a. Preferred postpartum during lactation
    b. Preferred in women over 35 years who smoke and have increased risk of cardiovascular disease
    c. None of the above
    d. All of the above

8. Rifampicin, Lopinavir/Ritonavir, Nevirapine are enzyme inducers that interact with oral contraceptives to
    a. Reduce contraceptive effect
    b. Increase contraceptive effect
    c. Stabilize contraceptive effect
    d. Have no effect on the contraceptive

9. Dual contraception with a barrier method is encouraged to prevent _____ _____

B2. MATERNAL/ANTENATAL CARE

Circle the correct answer of Fill the blank spaces with the correct answer as applicable.

1. All non-pregnant women of reproductive age should be advised to commence periconceptual folic acid supplementation (women planning pregnancy).
    a. True
    b. False

2. Every pregnant woman should have at least ____ antenatal clinic visits.
    a. 2
    b. 4
    c. 6
    d. 8

3. Which of the following lifestyle modifications are required by a pregnant woman for a healthy pregnancy and baby?

    i. no smoking
    ii. no alcohol intake
    iii. balanced diet
    iv. strenuous exercise

    a. All of the above
    b. None of the above
    c. I, ii, iii
    d. I, ii, iv

4. Which of the following are danger signs in pregnancy?

    i. nausea and vomiting
    ii. vaginal bleeding
    iii. baby not moving
    iv. severe abdominal pain

    a. All of the above
    b. None of the above
    c. i ii iii
    d. ii iii iv

5. When is ARV therapy initiated in newly diagnosed HIV positive pregnant women?
    a. Immediately HIV status is confirmed
    b. CD4 count <500 cells/mm^3
    c. Viral load <1000 IU/ml
    d. Immediately after birth

6. Which of the following is teratogenic?
    a. ACE inhibitors
    b. Vitamin A derivatives
    c. Statins
    d. A, B, C
    e.
7. Which of these factors influence the manifestation and severity of teratogenicity?
    a. Gestation period
    b. Dose and duration of therapy
    c. Degree of drug transfer across the placenta
    d. All of the above

Please answer questions 8, 9 and 10 in the table below according to the instruction at the top of the table. (4 marks)

Complaint	State one cause in the blank cell.	Give one Non-pharmacological treatment/prevention
8. Morning sickness	Reduced gastric motility, high hormonal levels	
9. Heartburn		
10. Vaginal thrush	Alteration in pH balance	

B3. NEONATAL AND CHILD CARE

Circle the correct answer or "I don't know" if you are not sure of the correct answer. Also, fill the blank spaces with the correct answer or "I don't know" if you are not sure of the correct answer.

1. Exclusive breastfeeding (EBF) is defined as giving only breast milk to infants for the first _____ of life.
   a. 2 months
   b. 4 months
   c. 6 months
   d. 12 months

2. An HIV exposed infant is one whose mother is HIV infected or whose HIV infection has not been confirmed or excluded. Which ARV medication is given to such infants at birth?

   _____

3. WHO recommends that HIV positive women who are on ART should exclusively breastfeed their babies?
   a. True
   b. False

4. Cracked nipples during breastfeeding is a result of
    i. poor positioning of the baby to the nipple
    ii. incorrect attachment to the nipple
    iii. removing the baby from the breast before suction is broken
    iv. breastfeeding the baby while lying down
    a. All of the above
    b. i ii iii
    c. i and iv

5. The Expanded Program on Immunization (EPI) covers the major killer diseases of infanthood. List three of such diseases. (3 marks)
_____
_____
_____

6. What is the first line treatment of diarrhea in infants and children according to the standard treatment guidelines?_____
_____

7. Deworming agents are initially given to children at _____, subsequently every _____.
    a. 6 months, 6 months
    b. 6 months, 12 months
    c. 12 months, 6 months
    d. 12 months, 12 months

8. Outline one pharmacological and non-pharmacological treatment for diaper/nappy rash (2 marks)
Pharmacological (according to STGs):_____
_____
Non-pharmacological:_____
_____

9. Which of the following may be used in the treatment of mastitis?
    a. Apply warm compresses
    b. Drink plenty of clear fluids
    c. Panado
    d. Antibiotics
    e. All of the above

C. SKILLS ASSESSMENT

The SLIP 213 class undertook a M&CH practical session in the first semester. Based on that exposure, please give a brief explanation to each of the following questions.

1. Please explain how an infant's (0-12 months) height is measured? (2 marks)

2. Should an infant be fully clothed or undressed during weight measurement? (1 mark)

3. How is an infant's head circumference measured? (2 marks)

4. Why is an infant's head circumference measured? (1 mark)

5. What is MUAC? (1 mark)

6. Why is MUAC measured? (1 mark) *

7. THE END. THANK YOU!!!

APPENDIX 3: Information sheet, consent form and questionnaire for 2017 fourth-year undergraduate pharmacy students (Cohorts 2, 3 and 4).

Dear BPharm IV Student

Information sheet for participation in research

Research title: The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape.

Background

High maternal and child mortality is one of the quadruple burdens of disease facing South Africa. The reduction in mortality rate between 2009 and 2015 falls short of the targets of the Millennium Development Goals (MDGs), consequently the Sustainable Development Goals (SDGs). Most deaths are from preventable and curable causes.

A focus of the National Development Plan (NDP) is the reduction of maternal and child mortality. Pharmacists as part of the health workforce should be equipped with the relevant knowledge and skill required to contribute to the reduction.

Aim of study

The aim of this study is to develop a framework for an integrated training program in Maternal and Child Health (MCH) for undergraduate pharmacy students at the University of the Western Cape (UWC).

Procedures

You are being asked to participate in this study because you are a BPharm IV student of the School of Pharmacy, University of the Western Cape.

If you agree to participate in this study,
- You will be asked to complete a questionnaire on MCH as a baseline study. The questionnaire will be returned to the investigator(s) for analysis.
- If on analysis of participants' responses a knowledge gap is identified, current curriculum content will be reviewed and updated. An intervention, a supplementary lecture in the form of a video will be made available to the BPharm IV class.
- Subsequently, you will be asked to complete a questionnaire in a post-intervention study. The questionnaire will be returned to the investigator(s) for analysis.
- A 50% score in each aspect of MCH (section of the questionnaire) is a pass mark.

The mark obtained may not contribute to your academic achievement. It may be purely for research purposes.

Confidentiality

Your name will not be used on the questionnaire or other printed materials associated with the study. A unique ID will be allotted to each participant. Study materials will be kept in a secure location where only the senior investigators will have access to it.

Voluntary participation

Participation in this study is voluntary. Your decision to take part in the study or not will not affect your interaction with UWC and the School of Pharmacy in any way. You can choose to withdraw from the study at any time.

Risks

You would not be at risk for participating in this study.

Benefits

You will be providing important information that will help in improving curriculum content in MCH. This will ensure that pharmacy graduates from UWC SOP are competent to participate in this area of health care.

Costs

There will be no cost to you for participating in this study.

Questions

If you have any questions, you may please speak to Mrs Elizabeth Egieyeh (0219592192, Office F12). If you are unsatisfied with the response given then please speak to anyone of the other programme co-ordinators:
Professor Angeni Bheekie: 0219592977, Office K6
Dr Mea van Huyssteen: 0219592864 Office F5
Dr Renier Coetzee: 0219593665, Office F6

Ethics approval

The University of the Western Cape Ethics Review Board and the Registrar has granted ethics approval.

If you have any comments or concerns about participation in this study, you should first talk with the researchers. If for some reason you do not wish to do this, you may contact the University of Western Cape Ethics Review Board, which is concerned with the protection of volunteers in research projects.

CONSENT FORM

Research title: The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape.

5. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

6. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.

7. I understand that the study will not affect my legal rights and the data collected will not be linked to me in any way and full confidentiality is guaranteed

8. It has been explained clearly to me that the study was approved by relevant ethics committee

9. I agree to take part in the above study.

Participant study number	Date	Signature of participant
Name of researcher	Date	Signature of researcher

QUESTIONNAIRE

Research title: TThe development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape.

Unique ID:_____

D. PERSONAL INFORMATION/ DEMOGRAPHCS (check as required)

6. AGE:

- ☐ 20 - 30 years
- ☐ 31 – 40 years
- ☐ 41-50 years

2. GENDER:

- ☐ Male
- ☐ Female

3. PARENTAL STATUS:

- ☐ Children
- ☐ No children

4. LOCUMING :

- ☐ Yes
- ☐ No

1. IF YES, HOW LONG:

- ☐ 1-2 years
- ☐ > 3 years

ALL QUESTIONS ARE ALLOCATED ONE MARK EXCEPT OTHERWISE INDICATED

B. KNOWLEDGE SECTION

B.1 REPRODUCTIVE/SEXUAL HEALTH (Circle the correct answer or "I don't know" if you are not sure of the correct answer. Also, fill the blank spaces with the correct answer or "I don't know" if you are not sure of the correct answer)

1. Which hormones are present in combined oral contraceptives?
    a. Eostrogen and progestogen
    b. Testosterone and oxytocin
    c. Prolactin and thyroxin
    d. Prolactin and oxytocin
    e. I don't know
2. Combined oral contraceptives should be started
    a. Between day 1 and day 5 of the cycle
    b. At any time in the absence of pregnancy
    c. After day 5 of the cycle with additional precaution (barrier method) until 7 hormonal pills have been taken
    d. All of the above
    e. I don't know
3. Which of the following contraceptive methods' effectiveness relies on the client's ability to use them correctly?
    a. Vasectomy
    b. Condoms
    c. IUD
    d. Sub-dermal implant
    e. I don't know
4. Long acting reversible contraceptives (LARC) are defined as methods that require administration once in months or cycles. Which of the methods listed below fall within this definition?
    i. Copper IUD
    ii. Levonorgestrel releasing intrauterine system
    iii. Progestogen-only injectables
    iv. Sub-dermal progestogen implants
        a. All of the above
        b. None of the above
        c. ii and iii
        d. i and ii
        e. I don't know
5. Emergency contraception is absolutely indicated after sexual intercourse in all of the following situations except
    a. One pill forgotten or 3 hours late with sexual intercourse in the past 5 days
    b. Two pills forgotten during the first 7 active pills
    c. > 2 weeks late for Progestogen-only injections
    d. <2 weeks late for Progestogen-only injections
    e. I don't know

6. The following information are important before emergency contraception is dispensed except one?
    a. Date of the last menstrual period
    b. <120 hours since the last episode of unprotected intercourse
    c. How many hours of rest observed
    d. Exclusion of pregnancy
    e. I don't know
7. Dual contraception is encouraged to prevent the transmission of _____
8. Oral progestogen-only pills are
    a. Preferred postpartum during lactation
    b. In women over 35 years who smoke and have increased risk of cardiovascular disease
    c. Disrupt the menstrual cycle
    d. All of the above
    e. I don't know
9. Rifampicin, Lopinavir/Ritonavir, Nevirapine are enzyme inducers that interact with oral contraceptives to
    a. Reduce contraceptive effect
    b. Increase contraceptive effect
    c. Stabilize contraceptive effect
    d. Terminate contraceptive effect
    e. I don't know

B.2 MATERNAL/ANTENATAL CARE (Circle the correct answer or "I don't know" if you are not sure of the correct answer. Also, fill the blank spaces with the correct answer or "I don't know" if you are not sure of the correct answer)

10. All non-pregnant women of reproductive age should be advised to commence periconceptual folic acid supplementation (women planning pregnancy). True or false or I don't know?
11. Every pregnant woman should have at least ____ antenatal clinic visits.
    a. 2
    b. 4
    c. 6
    d. 8
    e. I don't know

12. State 4 lifestyle modifications required by a pregnant woman for a healthy pregnancy and baby? (4 marks)

    _____
    _____
    _____
    _____

13. State 4 danger signs of pregnancy.(4 marks)_____
    _____
    _____
    _____

14. When is ARV therapy initiated in newly diagnosed HIV positive pregnant women?
    a. Immediately HIV status is confirmed
    b. CD4 count <500 cells/mm^3
    c. Viral load <1000 IU/ml
    d. Immediately after birth
    e. I don't know
15. Which of the following is non-teratogenic?
    a. ACE inhibitors
    b. Vitamin A derivatives
    c. Statins
    d. None of the above
    e. I don't know
16. Which of these factors influence the manifestation and severity of teratogenicity?
    a. Gestation period
    b. Dose and duration of therapy
    c. Degree of drug transfer across the placenta
    d. All of the above
    e. I don't know

Please answer questions 17, 18 and 19 in the table below according to the instruction at the top of the table. (4 marks)

Complaint	State one cause in the blank cell.	Give one Non-pharmacological treatment/prevention
!7. Morning sickness	Reduced gastric motility, high hormonal levels	
18. Heartburn		
19. Vaginal thrush	Alteration in pH balance	

B.3 NEONATAL AND CHILD CARE (Circle the correct answer or "I don't know" if you are not sure of the correct answer. Also, fill the blank spaces with the correct answer or "I don't know" if you are not sure of the correct answer)

19. Exclusive breastfeeding (EBF) is defined as giving only breast milk to infants for the first ____ _____ of life.
    a. 2 months
    b. 4 months
    c. 6 months
    d. 12 months
    e. I don't know

20. An HIV exposed infant is one whose mother is HIV infected or whose HIV infection has not been confirmed or excluded. Which ARV medication is given to such infants at birth?

_____

21. WHO recommends that HIV positive women who are on ART should exclusively breastfeed their babies. True or false?

22. Cracked nipples during breastfeeding is a result of
    i. Poor positioning of the baby to the nipple
    ii. Incorrect attachment to the nipple
    iii. Removing the baby from the breast before suction is broken
    iv. Breastfeeding the baby while lying down
    a. All of the above
    b. i, ii, iii
    c. i and ii
    d. Ii and iii
    e. I don't know

23. The Expanded Program on Immunization (EPI) covers the major killer diseases of infanthood. List three of such diseases. (3 marks)

_____

_____

_____

24. How is diarrhea treated in infants and children? _____

_____

_____

25. Deworming agents are initially given to children at _____, subsequently every _____.
    a. 6 months, 6 months
    b. 6 months, 12 months
    c. 12 months, 6 months
    d. 12 months, 12 months
    e. I don't know

26. Outline one pharmacological and non-pharmacological treatment ***for diaper/nappy rash*** (2 marks)

Pharmacological:_____

Non-pharmcological:_____

_____

27. Which of the following can be used in the treatment of mastitis?

a. Apply warm compresses
b. Drink plenty of clear fluids
c. Panado
d. Antibiotics
e. All of the above
f. I don't know

C. SKILLS ASSESSMENT (Please give a brief explanation to each of the following questions or "I don't know" if you are not sure of the correct answer)

28. Please explain how an infant's (0-12 months) height is measured? (2 marks) _____

_____

_____

_____

_____

29. Should an infant be fully clothed or undressed during weight measurement? (1 mark)

_____

_____

30. How is an infant's head circumference measured? (2 marks) _____

_____

_____

_____

_____

31. Why is an infant's head circumference measured? (1 mark) _____

_____

_____

32. What is MUAC? (1 mark)_____

_____

_____

_____

33. Why is MUAC measured? (1 mark) _____

_____

_____

_____

_____

UWC SOP MCH CURRICULUM CONTENT ASSESSMENT TOOL

Please put an X after any sub-topic that you have been exposed to in the course of your study at the School of Pharmacy.

Contraception:

- Contraceptive methods available in South Africa
- How the methods work
- Efficacy, when effective, duration of use
- Advantages and disadvantages
- Potential short term and long term effects
- Special precautions
- Possible problems to report
- Return to fertility
- Post coital contraception

Pre-pregnancy:

- Folic acid and iron supplementation provision for non-pregnant women of reproductive age in preparation for pregnancy
- HIV therapy provision for HIV positive non-pregnant women of reproductive age in preparation for pregnancy

Pregnancy care

- Lifestyle modifications for pregnant women
- Deworming agents during pregnancy
- Tetanus immunization protocols during pregnancy
- Treatment of infection (UTI, STIs, etc.)
- Importance of antenatal visits
- HIV treatment during pregnancy
- Provision of information on choices (abortion, adoption, etc.) in the case of unwanted pregnancy
- Maternal danger signs in pregnancy
- Medicines contraindicated in pregnancy
- Common conditions in pregnancy, management/treatment
- Role of pharmacists in pregnancy care

Post-natal care:

- Postpartum depression
- Suitable contraceptive methods
- Medicines contraindicated in lactating mothers
- Conditions associated with breastfeeding and treatment/management

Infant and child care:

- Exclusive breastfeeding, its importance and complementary breastfeeding
- Breast milk substitutes (infant formula) and other complementary feeding options for infants
- Children immunisation protocols
- Infant and children vitamin supplementation
- Treatment of infections in children (HIV, malaria, pneumonia, etc.)
- Treatment of diarrhoea in children
- Improving of drinking water
- Deworming
- Medicines contraindicated in infants
- Common infant problems, management/treatment
- Role of pharmacists in infant care

Service Learning in Pharmacy (SLIP):

Promote health and wellness

- Exclusive breastfeeding
- Lifestyle and nutrition
- Safe sex practice
- Contraceptive use
- Handwashing, personal hygiene

Drug administration

- Nevirapine
- Oral rehydrate
- Vitamin A supplementation
- De-worming agent
- Advice when infant vomits therapy

Road to Health Chart

- Infant weight, height taken
- Interpret/ evaluate growth
- Immunisation protocol
- Assess infant's dehydration status

*** THE END, THANK YOU!!***

APPENDIX 4: Pilot test questionnaire appraisal form.

Pilot test questionnaire appraisal form 2017

Dear BPharm IV Student

Research title: The development, implementation and evaluation of an integrated framework for undergraduate pharmacy education in maternal and child health at the University of the Western Cape.

Instruction:

You have been asked to complete this form because you volunteered to participate in the pilot test. Please appraise the pilot test questionnaire you completed by answering the questions below.

Thank you.

Questions:

1. Was any question vague/ambiqos/unclear? _____
2. Please give the number of the question and indicate which one of the terms in number 1. above applies to it. E.g.
   i. 10. Unclear
   ii.
   iii.
3. Was the time sufficient? _____
4. Were there too many questions in the questionnare?
   _____
5. Were the questions difficult to understand or answer?
   _____
6. Were the questions above the expected knowledge base of a 4th year pharmacy student?
   _____
   _____
   _____
   _____
   _____
7. Were the questions relevant to pharmacy practice?
   _____
   _____
   _____
8. Which one of the two parts of the survey would you have preferred to start with? Circle the preferred answer.
   i. UWC SOP MCH curriculum content assessment tool
   ii. Questionnaire

9. Was the information sheet and consent form easy to understand?

   _____

10. Is 70% a realistic pass mark?

    _____

11. Any other suggestions/comments/questions, please?

    _____

    _____

    _____

Thank you!

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APPENDIX 6: MDPI Pharmacy copyright agreement for open access publications.

Re:[Pharmacy] Manuscript ID: pharmacy-1340628; no consent needed form our side

External

Oct 15, 2021,
6:19 AM

to me, Pharmacy

Dear Mrs. Egieyeh,

Thanks for you inquiry.

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Kind Regards,

Assistant Editor