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COMPARING HOSPITALISATION AND COSTS OF DIABETES MELLITUS PATIENTS ENROLLED ON DISEASE MANAGEMENT PROGRAMS VERSUS NON-ENROLEES

By

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DECLARATION

I, Thulisile Busisiwe Noutchang, declare that this Research Report is my own unaided work. It is submitted for the Degree of Master of Public Health (Health Economics) degree at the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree at any other University.

Signature: _____

__26____ day of _____March _____2025_____ in _____Johannesburg.

DEDICATION

I dedicate this report to my husband, Alexis Noutchang, for his encouragement when I wanted to give up. I also dedicate this report to my three children, Mpumelelo, Lalonde, and Khanyalihle, for being patient with me when I was not mentally available. I hope they will understand someday.

A special dedication is made in memory of my late mother, Buhle Buthelezi, who believed in me.

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ABSTRACT

Aim

Type 2 diabetes mellitus (T2DM) is a chronic condition associated with poor health outcomes and high healthcare costs due to increased hospitalisations. The study aims to compare hospitalisation and costs for T2DM in medical scheme beneficiaries enrolled on a disease management program (DMP) and those not enrolled. Additionally, the factors associated with T2DM hospitalisation were identified.

Methods

This study adopted a quantitative and retrospective cross-sectional design using secondary hospital claims data from T2DM beneficiaries, which was primarily collected by the medical scheme. The study participants were made up of two groups of T2DM beneficiaries: those enrolled in the DMP and those who were not.

Results

We observed a 1.9% lower hospitalisation rate in the DMP group, with 30.58% of enrolees hospitalised compared to 32.57% of non-enrolees ($p < 0.001$). This reduction in hospitalisation rates was accompanied by fewer inpatient days among the 28 498 DMP enrolees compared to the 91 583 non-enrolees. Additionally, DMP enrolment was associated with cost savings of approximately ZAR R1.342 billion in hospitalisations, compared to ZAR R1.825 billion incurred by non-enrolees. The factors associated with T2DM hospitalisation were DMP enrolment, age, gender, healthcare access, geographical location, the number of chronic conditions, and insulin use.

Conclusion

The study demonstrates that enrolment in a DMP for T2DM beneficiaries is associated with significantly lower hospitalisation rates and shorter inpatient stays, resulting in substantial cost savings for the medical scheme. Additionally, factors such as age, gender, healthcare access, geographical location, the number of chronic conditions, and insulin use were identified as significant contributors to T2DM hospitalisation. These findings highlight the value of DMPs in improving health outcomes and reducing healthcare costs, supporting their continued investment and broader implementation within medical schemes. The evidence

provided by this study advocates for the ongoing and expanded use of DMPs as a critical component of chronic disease management strategies.

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CMS	Council for Medical Schemes
DMP	Disease Management Program
T2DM	Type 2 diabetes mellitus
TB	Tuberculosis
SA	South Africa
SEMDSA	Society for Endocrinology, Metabolism and Diabetes of South Africa
US	United States
HbA1c	Glycated Haemoglobin or Haemoglobin A1c
CCM	Chronic Care Model
PMBs	Prescribed Minimum Benefits
DKA	Diabetic ketoacidosis
CI	Confidence Interval
OR	Odds Ratio

CHAPTER 1: INTRODUCTION

This chapter provides an overview of the increasing prevalence of Type 2 Diabetes Mellitus (T2DM) and its impact on hospitalisation costs. It also examines how Disease Management Programs (DMPs) adopted by medical schemes help mitigate this burden. Additionally, the chapter reviews existing literature on the effectiveness of DMPs in reducing hospitalisations and associated costs. It outlines the study's rationale and objectives, which involve comparing hospitalisation and costs for T2DM beneficiaries enrolled in a DMP versus those not enrolled within a medical scheme.

1.1 Background

Type 2 diabetes mellitus (T2DM) is a prevalent and degenerative chronic condition associated with poor health outcomes and high healthcare costs ((1–5). Its high prevalence has become a global public health issue, affecting approximately 462 million people, or 6% of the world's population ((6,7). According to reports, the disease causes about 1 million disease-related deaths globally, ranking it as the ninth leading cause of mortality ((2,8). In South Africa (SA), T2DM is the second most prevalent condition after tuberculosis (TB), affecting 6.5% of adults aged 20-79 (9–11). In 2019, the disease was responsible for approximately 90,000 diabetes-related deaths ((9,12). In South Africa’s medical schemes industry (private healthcare insurance), T2DM has been estimated to affect approximately 50.86 per 1000 of its beneficiaries ((12,13).

Due to its progressive nature, the management of T2DM requires continuous clinical and management practices, which are associated with increased healthcare costs ((14). Hospitalisation is one of the primary factors contributing to healthcare costs, as individuals with T2DM are typically hospitalised 2 to 6 times more than those without disease-related complications ((4,15–17). In addition, T2DM patients typically have longer hospital stays than non-T2DM patients. As a result, hospitalisation costs for T2DM patients are 2.3 times higher than those without T2DM conditions ((18). For example, a European study found that 90% of hospital admissions were related to T2DM compared to people without diabetes, resulting in annual hospital spending of £36 billion ((19).

The consequences of T2DM hospital care have also been reported in other countries. In Canada, hospital care has been reported to account for 50% of its healthcare budget, Sweden for about 57%, and Taiwan for 14% to 48.7% (13). A similar picture has been observed in

medical schemes, in which T2DM hospital costs increased by 23.5% between 2013 and 2014 ((20).

T2DM healthcare costs (including hospitalisation) are further exacerbated by the presence of comorbidities and disease-related complications such as cardiovascular disease, neuropathy, nephropathy, and retinopathy, which increase healthcare service utilisation (9,11,20). Several studies have estimated that about 30% to 35% of healthcare expenditures for diabetes are attributable to complications due to increased medical care (21). For example, a study by Erzse et al. (2019) (14) in South Africa's public sector showed that 49% of the 51% (direct healthcare costs) of T2DM healthcare costs by 2030 will be attributed to complications. In medical schemes, treatment costs for managing disease-related conditions, such as renal failure, can be as high as ZAR R10,400 per person per month (pppm) (20).

The outcomes mentioned above (increased hospitalisation and healthcare costs) occurred despite the availability of several treatment practice guidelines published at the international level and the 2017 Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) guidelines ((14,22). The SEMDSA treatment guidelines were formulated to guide the most appropriate management for people with diabetes, which may include lifestyle changes such as diet and management of clinical process markers ((22). These clinical markers are considered appropriate as a measure of the quality of care for diabetic patients ((20,22). These may include the following: annual glycaemic levels (blood sugar), defined as a glycated); annual (HbA1c) test, which is a critical indicator for T2DM management; annual renal function test (to check whether a patient is developing renal failure); an annual eye or fundal examination (eye function to test whether the patient is developing retinopathy); annual an LDL/lipogram test (to test the amount of cholesterol in the blood); and drugs to reduce the amount of cholesterol.

1.2 Disease Management Program

In response to rising healthcare expenses and poor health outcomes associated with T2DM, policymakers have recommended strategies that contain healthcare-related costs while also improving diabetic patients' long-term health ((23,24). One of these strategies is disease management programs (DMPs) for T2DM and similar chronic illnesses. The purpose of the DMP is to optimise healthcare resource utilisation while improving care for those with chronic illnesses ((24–26). DMPs were first implemented as a "health system transformation" in the United States (US) in the early 1990s (27). Their goal was to provide systematic and

organised care, optimise chronic disease management throughout the healthcare system's continuum of care, and contain healthcare costs ((28,29). This program was driven by the standard of care's challenges ((29,30), which were primarily: fragmented, uncoordinated, or unstructured; not patient-centred but reactive; did not promote self-management skills nor; emphasised adherence to care guidelines.

According to de Bruin et al. (2011) (30), DMPs are a "patient-centred approach of coordinated multiple healthcare interventions that structure chronic care for a specific patient group". In other settings, the program is known as "case management, integrated care, and managed care. Globally, the DMP is known as a delivery vehicle for the Chronic Care Model (CCM) that was developed by Wagner et al. (2001) (29,31). The CCM utilises six interconnected components to manage chronic illnesses, which are: coordination of the healthcare system (leadership in securing resources and removing barriers to care); support for patients' self-management (enabling skill-based learning and patient empowerment); guidance for decision-making (helping implement evidence-based care); design of the delivery system (coordinating care processes); clinical information systems (tracking progress by reporting outcomes to patients and providers); and community resources and maintenance of treatment (sustaining care by using public health policy and community-based resources).

DMP, in turn, may employ several components of CCM, which are to identify the chronic population (disease-specific); provide systematic and comprehensive care; promote adherence to evidence-based practice guidelines; develop multidisciplinary and collaborative practice models; educate patients and providers on self-management and measuring clinical outcomes; routinely report and provide feedback to patients and providers.

The strength of the DMP lies in bringing a multidisciplinary team of healthcare providers together to collaborate and give patients access to specialised care, knowledge, information, and assistance for successfully managing T2DM (32). Implementation of DMP is supported by treatment guidelines, which recommend a multidisciplinary approach for in-and-out hospital care for patients with diabetes (33). For instance, for T2DM, which is a progressive condition with a complex treatment pathway, DMP brings in a multidisciplinary team of healthcare professionals. Members of the team can include physicians, nurses, pharmacists, occupational therapists, physiotherapists, clinical psychologists, social workers, diabetes educators, dieticians, and podiatrists for diabetes management and treatment ((11,34). The benefits of a multidisciplinary diabetes team include access to multiple experts for enhanced

patient education, better glycaemic control, increased patient follow-up, greater patient satisfaction, a lower risk for diabetes complications, improved quality of life, reduced hospitalisations and decreased health care costs (35).

1.3 Disease Management Program in South Africa

DMPs for T2DM and other chronic illnesses have been a part of the medical scheme in South Africa since 1996 (32,36–42). They were introduced to improve healthcare outcomes by making arrangements that will enable the control of costs due to healthcare service overutilisation. Since the early 2000s, these programs have been offered as voluntary enrolment, in which providers contracted to medical schemes provide a comprehensive healthcare package to beneficiaries (11). The care is based on a minimum level of care in accordance with the Prescribed Minimum Benefits (PMBs), as listed in the Medical Schemes Act, 1998 (Act No. 131 of 1998) (43).

Reimbursement of DMP services is done through various payment structures, such as capitation, fee-for-service and flat-rate payment, depending on the size of medical schemes and the profile of beneficiaries (11,20). In the capitation model of care, medical schemes establish risk pools for each DMP provider to act in the patient's overall best interest, as payment is made prospectively as a cost-containment strategy to reduce healthcare costs while improving patient outcomes. The financial incentive for capitation payments for DMP providers is to enrol as many beneficiaries as possible. However, there is a risk of selection bias in enrolling healthier beneficiaries and under-provision of services.

The healthcare package offered by DMP providers can vary from one service provider to another (11,20). Generally, the package for diabetes-related services is through referral and liaison networks to provide the following: hospital benefit management; active and supportive disease management; pharmaceutical benefit management; and other areas such as dental benefits management. Out-of-hospital diabetes-related services may include medical care from various health specialists, including general practitioners, medical specialists, allied health professionals, pharmaceuticals, and medical consumables. The only in-hospital diabetic emergencies covered are restricted to diabetic ketoacidosis (DKA) and hypoglycaemia crises by the DMPs. The patient’s continuum of care is monitored using a tracking system to manage the patient’s outcomes and control wastage and duplication of healthcare services to contain healthcare costs, including unnecessary hospitalisation ((36,40,44).

As in other health systems, DMP implementation in medical schemes is based on clinically proven and cost-effective treatment guidelines (44). These guidelines aim to empower healthcare providers and patients to take proactive measures to control their conditions. In the case of DMP for T2DM, a range of patient-tailored services are offered through integrated care, including annual consultations with dieticians and biokinetics. In diabetics with cardiovascular comorbidities or complications, DMP providers collaborate with organisations specialising in cardiovascular care. Through this partnership, a patient's continuum of care is monitored using a health information and data-sharing system. This partnership facilitates the management of the patient's health outcomes as well as the prevention of wasteful spending and duplication of medical services, which aim to contain healthcare costs, including avoidable hospitalisation ((36).

Although DMPs have been used as a cost-containment strategy, it is unclear how these programs affect hospitalisations and health outcomes for T2DM medical scheme beneficiaries ((11,45). The available evaluation evidence is not extensive and inconsistent, as healthcare expenditures reveal growing hospitalisation costs (46). A DMP evaluation using hospitalisation and hospitalisation costs as proxies and primary outcomes will assist medical schemes in understanding the value of their investments. Thus, the study’s objective is to evaluate the association between DMP enrolment and hospitalisation among T2DM medical scheme members by examining the annual proportions of hospitalisations and the average hospitalisation costs incurred. This research aims to inform future policy decisions and optimise resource allocation to benefit the medical scheme and its T2DM members. The study hypothesises that DMP enrolment is associated with reduced hospitalisation among T2DM medical scheme beneficiaries on a DMP compared to those not on a DMP.

1.4 Literature review

The realities of resource constraints and high healthcare demand are known, and medical schemes, like all healthcare systems, are faced with decisions on how and where to allocate the necessary services (41,47). Measuring healthcare system efficiency is critical in assessing whether resources yield a return on investment in healthcare programs such as DMP while promoting and improving health outcomes.

Several studies have shown an association between the adoption of DMPs and T2DM patient outcomes and healthcare costs, especially those related to hospitalisation ((48–54). The significant outcome of these studies was a reduction in healthcare costs, including fewer hospitalisations ((48,49,53,55). However, the results of other studies have reported conflicting findings ((11,26,33,36,56,57). The following literature review focuses on DMP evaluation studies conducted on outcomes in hospitalisation and hospitalisation costs as proxies of DMP evaluation for T2DM. The review is divided into the following sections: favourable and unfavourable outcomes of DMP on T2DM hospitalisation.

1.4.1 Favourable Outcomes

Treatment guidelines have emphasised equipping diabetes patients with diabetes self-management skills through healthcare education and other treatment protocols (52). DMPs have successfully demonstrated this phenomenon in several studies. In South Texas, USA, research was conducted by Smith et al. (2021) (48) to investigate the efficiency and cost savings of diabetes education programs (DEP) for Hispanic individuals. Education focused on the patient's self-management of HbA1c levels. The study's data was retrieved from a database of 3859 participants who attended DEP. The effect of DEP was evaluated by measuring HbA1c levels every three months over a 1-year period. The primary and secondary study outcomes were HbA1c level and healthcare cost, respectively. The analysis was conducted using an independent sample t-test and linear mixed-model regression to evaluate the changes in HbA1c over time. The analysis results demonstrated a significant correlation between enrolment in a DEP and lower HbA1c readings, as well as decreased hospitalisation costs, ranging from 5.3 to 5.6 million.

In support of the results of the study by Smith et al. (2015) (48), Hamar et al. (2015) (49) in Australia also studied the impact of DMP on patient health education. This study aimed to assess the long-term impact of a DMP on hospital utilisation and healthcare costs by providing individualised support through telephonic nurse outreach and online tools for self-

management and behaviour change. The study's data came from hospital claims during a four-year period, covering 4948 people registered on DMP and 28,520 not. Hospital admission, readmission, total bed days, and healthcare costs were the primary outcomes evaluated using logistic regression analysis. The analysis entailed comparing the outcomes between the two groups. The results showed that DMP health education was associated with a significant reduction in bed days, readmissions, and hospital admissions in patients with diabetes or heart disease compared with the non-DMP group. Over a four-year period, the program also produced cumulative average cost savings of $3,549 and long-lasting benefits for patient health education. Similar results were obtained in terms of reduced bed days in a study conducted by Riedl et al. (2016) (58) which found that DMP enrolment (Austrian Disease Management Program (DMP)) is associated with a cumulative reduced number of hospital days and mean annual hospital costs compared to non-participants.

Several studies have demonstrated the benefits of specialised multidisciplinary programs or diabetes intervention teams as components of DMP. This effect on the 30-day and 365-day hospital readmission rates of diabetic patients was evaluated in the United States (U.S.) ((59)). A cohort of patients participated in this study; 95 were in a DMP group, and the remaining 97 were not. Individualised care plans created by trained diabetes educators or nurse practitioners, nutritionists, social workers, and endocrinologists were part of a specialised multidisciplinary diabetes program. The analysis using a randomised controlled prospective design showed that 30 days after discharge, the DMP group had lower overall hospital readmission rates of 7%, compared with 19% in the control group. Similarly, the overall hospital readmission rate during a 365-day period was 14% in the intervention group and 38% in the control group.

A strength of DMP is the coordinated use of clinical Health-Information System to monitor and track patients' clinical markers. A study in Taiwan investigated the use of the Diabetes Shared Care Program (DSCP), which is based on a health information system, to reduce preventable hospitalisations among diabetic patients ((51). This study used a descriptive analysis of healthcare claims data between 2011 and 2014 obtained from the health information system database. The health information system recorded patients' medical history, monitored the quality of care, and provided case management services between multidisciplinary diabetes care teams. The study's results showed an association between improved diabetes management and glycaemic control, potentially reducing hospitalisation

costs and improving health outcomes. The study suggests that health information-based programs should be promoted on a broader scale in diabetes management.

The integration of pharmacists as one of the DMP components has also been evaluated (52,60,61). Pharmacists, in addition to dispensing medication, also offer patient education, direct patient care responsibilities, and chronic disease management through team-based care. Two studies have investigated this effect. The first study was a systematic review to evaluate the impact of including pharmacists in diabetes management with physician-nurse collaboration (52). The studies reviewed utilised cost-effectiveness analysis to evaluate the effect of pharmacist professional services as an intervention for diabetes management. The review results showed that integrating pharmacists into a diabetes management program is cost-effective compared with standard care. The second review was a randomised controlled trial in Singapore, with 214 patients with T2DM in the intervention group and 197 in the control group ((61). The study population comprised high-risk patients above 21 years with uncontrolled T2DM, polypharmacy (five or more medications), and comorbidities. The study's objectives were to evaluate the impact of pharmacist-involved multidisciplinary care on clinical (HbA1c), humanistic, and cost outcomes compared to physician-centred care in managing diabetes. The results showed that the intervention group, which received multidisciplinary collaborative care, demonstrated a significant reduction in HbA1c levels, whereas the control arm showed no change. The multidisciplinary approach led to decreased physician workload and an average cost savings of US$91.01 per patient over 6 months.

The integration of nurses as a critical component of DMPs has been evaluated in various contexts. One such study examined the effectiveness of nurse-directed diabetes care in reducing preventable diabetes-related urgent care/emergency room visits and hospitalisations among a minority population (62). This study used a retrospective and descriptive analysis of public health clinic data of T2DM patients. The study participants were randomly selected, and measurements were taken to evaluate the frequency of urgent care/emergency room visits and hospitalisations one year before and during enrollment in the DMCP. Findings revealed a substantial 51% reduction in diabetes-related urgent care visits and hospitalisations, with 94 total visits recorded in the year before DMCP enrollment compared to 46 visits during the DMCP year. This significant decrease in hospitalisation suggests that nurse-directed care is associated with improved health outcomes and reduced acute care utilisation. Another study evaluated the efficacy of nurse-led interventions within DMPs, focusing on the impact of culturally tailored care on diabetes management. The intervention incorporated a nurse case

manager (NCM) and a Community Health Worker (CHW) team (63). The objective was to assess whether culturally appropriate strategies could improve diabetes care. In this study, 542 African American participants with T2DM were randomly selected and assigned to either an intensive or a minimal intervention group. The intensive intervention provided individualized care from a nurse case manager and community health worker using evidence-based clinical guidelines with regular feedback to primary care providers (e.g., physicians, nurse practitioners, or physician assistants). The minimal intervention group received mailings, and telephone calls every 6 months to remind participants about preventive screenings. After 24 months, the results showed that, the intensive group had 23% fewer emergency department visits compared to the minimal group.

A review of the impact of DMP on hospitalisation risk and healthcare expenditures was also evaluated in Sweden. The study's data sources were from the claims data of a large Swiss health insurer with 800,000 (10% of the country's population) insured persons in 2019 ((53). This was a prospective observational design in which propensity score matching and difference-in-difference (DiD) were used for analysis. Propensity score matching (PSM) is commonly used to reduce bias from concomitant confounding variables and correct baseline imbalances. These methods were used to compare 550 patients on a DMP and 5050 not enrolled on a DMP in terms of adherence to a treatment care guideline, risk of hospitalisation, and healthcare costs. Evaluation of the study's outcomes yielded a positive impact of the DMP on the quality of diabetes care and a reduction in hospitalisation risk in the DMP group, particularly in the 1-year follow-up. Additionally, the increase in health care costs was smaller in the intervention group than in the control group, although not statistically significant.

In South Africa, a study evaluating the implementation of an integrated multidisciplinary team of a DMP known as the Centre for Diabetes and Endocrinology (CDE) was conducted in early 2002 by Distiller et al. (2010) ((54). The objective of the study, using the descriptive method, was to evaluate the effect of a multidisciplinary team comprising general practitioners, nurses, dieticians, podiatrists, and endocrinologists on hospitalisation and glycaemic control. The study was based on a cohort of 8026 patients with type 2 diabetes enrolled in CDE's DMP for more than 5 years. The results of the study showed that a multidisciplinary team led to a reduction in hospital admission rates by 40% and improved glycaemic control. The progression of microvascular complications also appeared to have been delayed.

1.4.2 Unfavourable Outcomes

Although it is widely believed that disease management programs reduce healthcare service utilisation and healthcare costs, some studies have reported the opposite results. One such finding is shown in a systematic review by de Bruin et al. (2011) (30). The objective of the study was to evaluate the impact of DMP on healthcare costs. The review entailed a PubMed search of thirty-one papers for patients with diabetes, depression, heart failure, or COPD. The results showed notable variation in the impact of disease management programs, with some studies reporting incremental cost savings of $16,996 to $3305 per patient and others reporting increased costs. Additionally, DMP was found to be potentially effective for patients with heart failure, leading to reduced hospitalisation rates and emergency room visits. In contrast, the evidence was less conclusive for patients with diabetes, depression, COPD, and asthma.

In another paper, a study was conducted in Germany to evaluate DMP cost-effectiveness and their life-prolonging effect as outcomes on T2DM patients (56). The assessment was conducted using an incremental cost-effectiveness ratio (CER) by comparing real-life costs among 19,888 T2DM DMP participants and T2DM patients in routine care (RC). The annual mean costs for survivors and the last year of life costs for the deceased were also evaluated. The results indicated that DMPs are cost-effective, with an incremental cost-effectiveness ratio of 1396 euros per life-year gained; however, there was an increase in costs. The study also revealed a significant survival benefit for DMP participants, resulting in a life-prolongation of 20 days per year of DMP participation.

The benefits of DMP in educating patients on disease self-management and HbA1c levels have been emphasised as a key component in controlling healthcare costs. However, an Australian study assessing the impact of DMP's specialised glucose management teams (GMTs) on improving glycaemic control in hospitalised patients with diabetes and hyperglycaemia found opposite results ((33)). This study entailed a retrospective review of 440 diabetic patient files who were admitted for cardiac or infection-related diagnosis. The review compared two cohorts of T2DM patients receiving glycaemic GMT with those who were not. The primary outcomes measured were morbidity, death during hospitalisation, hospital re-admissions, etc. The analysis of the outcomes found no significant difference in the primary outcomes between the usual care group and the GMT group. However, GMT-managed patients demonstrated improved glycaemic variability and control.

Conflicting results were also reported by a retrospective cohort study of 33 970 patients in the DMP and 18 017 not on a DMP in Denmark between 2008 and 2014 (57). The objectives of the study were to evaluate the association between the annual healthcare costs of patients with type 2 diabetes and the use of an electronic health record (EHR) system with a DMP. The following outcomes: primary care, medication, non-hospital specialists, and total hospital costs (outpatient, inpatient, and emergency) were analysed using a regression model. The study results showed that the use of EHR/DMP was associated with a 3.2% increase in annual primary care costs and a 6.4% decrease in annual emergency hospital visit costs but no significant change in total healthcare costs.

In South Africa, a study by Naidoo et al. (2019) (36) was conducted to examine the hospitalisation rates of patients with T2DM with and without major depressive disorder (MDD), all enrolled in the DMP. This study was a retrospective review of a cohort of 902 adult T2DM patients with a privately managed healthcare organisation. It was found that T2DM patients with MDD had a higher rate of hospitalisation and greater non-diabetic-related hospital events compared with those without MDD. Additionally, hospitalisation costs were significantly higher for diabetes-related admissions in the non-MDD group due to a higher number of macrovascular events. The study concluded that patients with both T2DM and MDD have a higher number of hospitalisations than their non-MDD counterparts, emphasising the need for integrated disease management to improve patient outcomes and reduce the healthcare burden.

Another local study by Naidoo et al (2022) (11) investigated the direct medical costs of patients with T2DM within a private healthcare insurer using two funding models: a capitated risk-sharing model (CM) and a traditional fee-for-service (FFS) model. The capitation payment in healthcare is used as a cost-containment strategy to reduce healthcare costs while improving patient outcomes. The study entailed a descriptive and retrospective review of claims data from a cohort of patients with T2DM in these two models between 2012 and 2016. Results of the analysis found that patients on a CM had higher healthcare costs that accrued significantly compared with patients on the FFS model. The most significant contributor to these costs was associated with increased hospitalisation.

T2DM treatment guidelines have emphasised continuous control of clinical markers as a measure of good quality of care (14). A study of DMP on providing quality care to medical scheme beneficiaries as per T2DM SEMDSA guidelines on hospitalisation has been conducted (20). The study entailed a descriptive and retrospective review of data that medical

schemes had submitted to the Medical Scheme regulator between 2013 and 2014. The study measures were process indicators measured as the number of beneficiaries receiving clinical care as per guidelines such as two HbA1c tests. The outcome indicators were the number of beneficiaries hospitalised as a day-case and long hospital stay (more than one day) and hospitalisation costs. The study results showed a relatively low level of monitoring of process indicators. In 2014, there was a 1.7% increase in the number of beneficiaries receiving at least two HbA1c tests compared to those in 2013. In terms of hospitalisation, the number of beneficiaries hospitalised as day cases had decreased by 0.4% from 10.3% in 2013. However, the number of beneficiaries who were hospitalised for longer than a day increased by 1.2% in 2014 compared to 2013. The overall hospitalisation costs per person per month (pppm) increased by 23.5% between 2013 and 2014.

1.4.3 Overview: Literature review

Among the studies reviewed, the components of DMP implementation varied depending on the setting and the different methodologies used, which cannot be generalised. The evaluation methods ranged from descriptive analysis, retrospective, randomised controlled trials, sample t-tests, regression models, the incremental cost-effectiveness ratio (ICER) and the difference-in-difference (DiD) and propensity score matching, just to name a few. In South Africa, studies on the impact of DMP on hospitalisation and hospitalisation costs are limited, with contradictory results.

This study will compare hospitalisation and costs of type 2 diabetes mellitus patients enrolled in disease management programs versus non-enrolees using an independent sample t-test. A logistic regression model will be used to determine the factors associated with T2DM hospitalisation among medical scheme beneficiaries in 2019.

1.5 Problem statement

Medical schemes have increasingly invested in Disease Management Programs (DMPs) as a strategic response to the growing prevalence of chronic conditions such as type 2 diabetes (T2DM) and their associated healthcare costs ((44,64–68). DMPs for T2DM are based on the concept that they can effectively improve healthcare outcomes for individuals suffering from chronic diseases while simultaneously containing related costs, particularly those associated with hospitalisation ((30,40,48,49,51,53,54,59). However, the financial realities within medical schemes paint a concerning picture, as the total healthcare expenditure costs on benefits paid in 2019 increased to ZAR R185,9 billion, an 8% increase from 2018 ((68). In

terms of T2DM hospitalisation expenditure, it was reported that they increased by 23.5% between 2013 and 2014 (20).

The upward trend in total healthcare costs and T2DM hospital care spending suggests that such investments in DMPs may not yield the anticipated financial benefits. This raises important questions concerning the alignment and effectiveness of these programs relative to the growing prevalence of T2DM. While DMPs seem theoretically sound, the reality of their performance in a dynamic healthcare environment, particularly as challenging as that encountered in South Africa, might present a more complex scenario.

1.6 Rationale

The medical scheme environment, like any healthcare system, has limited available resources to meet the increasing demands for healthcare services, especially in the management of chronic diseases such as type 2 diabetes mellitus (T2DM) (44,45,67). Disease Management Programs (DMPs) for T2DM and other chronic conditions have become a viable approach for medical schemes to keep them financially stable and sustainable to remain in this competitive and volatile environment (45). Thus, evaluating DMP on T2DM hospitalisation is pivotal for the medical scheme which is being referred to in this study to understand the value of its resource investment. Without such evidence, the medical scheme, like all resource-constrained healthcare systems, may not have a compelling reason to continue using and investing in DMPs.

The rigorous evaluation of the efficacy of DMPs from both clinical and financial perspectives cannot be overstated. This will serve as the basis on which the medical scheme can base its investment decisions, including the justification for the continued support of DMPs. The absence of concrete evidence regarding the benefits of DMPs undermines the confidence of the medical scheme's health funders and decision-makers. Moreover, with healthcare expenditure rising and consequently driving up premium costs, the importance of DMP evaluation for T2DM becomes even greater for medical schemes to employ evidence-based rationales to guide resource allocation (45,64,65).

1.7 Research question

How do hospitalisation and hospitalisation costs of T2DM compare for beneficiaries enrolled on a DMP and non-enrolees?

1.8 Study aim and study objectives:

This study aims to compare hospitalisation and hospitalisation costs for the T2DM medical scheme enrolled on a DMP and those not enrolled. The study objectives are:

a. To estimate the annual proportions of hospitalisations for T2DM medical scheme beneficiaries in 2019 in South Africa.

b. To estimate the average hospitalisation costs of T2DM medical scheme beneficiaries on DMP and no-DMP in 2019 in South Africa.

c. To determine the factors associated with hospitalisation for T2DM medical scheme beneficiaries in 2019 in South Africa.

CHAPTER 2: METHODOLOGY

2.1 Introduction

This chapter describes the methods used to answer the study objectives set out in Chapter 1.

2.2 Study site

The study was conducted in South Africa using data from one of the largest medical schemes. The medical scheme provided 2019 hospital claims data for T2DM beneficiaries to use for the research study.

2.3 Study design

This study adopted a quantitative and retrospective cross-sectional design using secondary data of T2DM beneficiaries, which was collected primarily by the medical scheme. The study participants were made up of two groups of T2DM beneficiaries: those enrolled in the Disease Management Program (DMP) and non-enrolees. The cross-sectional design was chosen for this study as it is observational in nature, allowing researchers to assess the relationship between an exposure and an outcome at a specific point in time without the need for longitudinal follow-up, such a cohort design (69,70). The cohort design was not chosen for this study as it would have required researchers to observe the outcomes resulting from a specific exposure over time. In this study, the exposure was enrolment in DMP, and the outcome was hospitalisation rates, which were compared between DMP enrollees and non-enrollees in 2019 (70).

Compared to other study designs, a cross-sectional approach is inexpensive, easy to conduct and time-efficient, as it leverages existing secondary data and does not require prolonged follow-up periods as in a cohort (69). Given the large sample size and the availability of robust secondary data, a cross-sectional design allowed for precise statistical comparisons between the T2DM beneficiaries while minimising the constraints associated with longitudinal studies.

2.4 Study population and study sample

The study population were all active beneficiaries registered with the medical scheme in 2019. The number of beneficiaries was 2.81 million in 2019. There was no sampling in this study as the inclusion criteria included all beneficiaries diagnosed with T2DM, who were

active beneficiaries of the medical scheme at any point between January 1, 2019, and December 31, 2019. The age group of beneficiaries was 18 and above.

2.5 Data collection

The study utilised secondary data primarily collected by the medical scheme. Permission to access the dataset was obtained from the medical scheme's Principal Officer. Table 1 provides the data specifications for the study.

Table 1: Data specification

Variable Name	Variable Description	Data Type	Variable Use
Year	Financial year	Discrete	Year of data collection
Age_band	Age categories	Categorical	Grouping of beneficiaries by age for hospitalisation analysis.
Gender	Male or female, coded as "0" for males and "1" for females	Categorical	Gender of the beneficiaries to explore any gender-based differences in hospitalisation rates.
Province	The geographical location of the beneficiary	Categorical	Analyse geographic impact on hospitalisation rates
Benefit_plan	Beneficiary's benefit option	Categorical	Assesses the impact of the benefit plan on hospitalisation risk
DMP_status	Either 'DMP' OR 'NO DMP' indicating whether the beneficiary was registered.	Categorical	To categorise beneficiaries by DMP enrolment
Insulin_indicator	Indication as to whether the beneficiary was on insulin or not	Categorical	Evaluate insulin use effect on hospitalisation risk.
Hospitalisation_indicator	Indicator whether the T2DM beneficiary was hospitalised	Categorical	Indicate if the beneficiary was hospitalised.
Total_inpatient_days	Number of days beneficiary spent in the hospital	Continuous	Analyse the duration of hospitalisation.
Overall_hospitalisation_costs incurred by beneficiary	Total cost of hospitalisation	Continuous	Estimates costs of hospitalisation.
CDL_1	One more chronic condition in a T2DM beneficiary	Categorical	Impact of one additional chronic condition on hospitalisation.

Variable Name	Variable Description	Data Type	Variable Use
CDL_2	Two more chronic conditions in a T2DM beneficiary	Categorical	Impact of two additional chronic conditions on hospitalisation
CDL_3	Three more chronic conditions in a T2DM beneficiary	Categorical	Impact of three additional chronic conditions on hospitalisation.

2.6 Data Management

The dataset was stored in Microsoft Excel, which was password-protected in the University of Witwatersrand's OneDrive and accessible only to the principal investigator. The data was provided in a disaggregated and anonymised format for each variable of interest. For the analysis, the dataset was exported to STATA statistical software version 18. The data cleaning process included checking for missing values, outliers, and inconsistencies. Various statistical techniques were then applied using STATA to generate the results.

2.7 Data analysis

A comprehensive descriptive analysis was conducted to examine the characteristics of T2DM beneficiaries stratified by DMP enrolment status, as shown above in Table 1. Categorical variables were presented as frequencies and percentages. The continuous variables were described using mean and standard deviation for normally distributed data and median and interquartile range for non-normally distributed data. This analysis provided a detailed overview of the demographic and clinical profiles of the beneficiaries, including those enrolled in the DMP and those not enrolled.

2.7.1 Objective 1: Estimation of the proportion of T2DM hospitalisation per DMP status in 2019

Variables:

The variables used to process this objective were the Year (2019), DMP status and the hospitalisation indicator. The year variable established the timeframe for the analysis, while the DMP status variable allowed us to categorise beneficiaries into two distinct groups: those enrolled in the DMP and non-enrolees. The hospitalisation indicator was used to identify whether beneficiaries had been hospitalised or not.

Beneficiary Categorisation

Beneficiary categorisation was crucial for comparing hospitalisation rates between the two groups. Within each group, beneficiaries were further categorised based on their hospitalisation status into two categories: “Hospitalised (Yes)” for those who had been hospitalised and “Hospitalised (No)” for those who had not. This additional classification allowed for a detailed comparison of hospitalisation rates within each group.

To aid in this analysis, a contingency table (Table 2) was created to visualise and summarise the data. This table shows the counts of hospitalised and non-hospitalised beneficiaries for both DMP enrolees and non-enrolees:

Table 2: Contingency table hospitalisation by DMP status

	Hospitalised (Yes)	**Hospitalised (No)**	**Total**
DMP Enrolees	a	b	a + b
Non-DMP Enrolees	c	d	c + d
Total	a + c	b + d	N

a: Number of hospitalised DMP enrolees

b: Number of non-hospitalised DMP enrolees

c: Number of hospitalised non-DMP enrolees

d: Number of non-hospitalised non-DMP enrolees.

Hospitalisation proportions:

The proportion of hospitalisation for each group was estimated to compare the hospitalisation for DMP enrolees versus non-enrolees. The proportions were calculated by dividing the number of hospitalised beneficiaries by the total number of beneficiaries within each group. Specifically:

- Proportion of Hospitalisation for DMP Enrolees: =a/(a + b)
- Proportion of Hospitalisation for Non-DMP Enrolees: =c/(c +d).

Hypothesis Testing

To assess whether the observed differences in hospitalisation proportions between DMP enrolees and non-enrolees were statistically significant, we formulated the following hypotheses:

- Null Hypothesis (H_0): There is no statistically significant difference in the proportion of hospitalisations between T2DM beneficiaries enrolled in the DMP and those not enrolled in the DMP in 2019.
- Alternative Hypothesis (H_1): There is a statistically significant difference in the proportion of hospitalisation between T2DM beneficiaries enrolled in the DMP and those not enrolled in the DMP in 2019.

Chi-Square Test for Independence:

To test these hypotheses, a Chi-Square Test for independence was conducted to determine if there was a statistically significant difference between the proportions of hospitalisation between DMP enrolees and non-enrolees. The chi-square statistic was computed using the formula:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where:

- O_i represents the observed frequencies.
- E_i represents the expected frequencies, calculated as:
  $$E_i = \frac{(\text{Row total of i-th cell} \times \text{Column total of i-th cell})}{\text{Grand total}}$$

Results interpretation:

The Chi-Square Test produced a p-value indicating whether the difference in hospitalisation proportions between DMP enrolees and non-enrolees was statistically significant. If the p-value was less than 0.05, we rejected the null hypothesis, suggesting that the difference in hospitalisation proportions was statistically significant and unlikely due to chance.

Conversely, if the p-value was greater than or equal to 0.05, we failed to reject the null hypothesis. This would suggest that there was no statistically significant difference in hospitalisation proportions between the two groups. The results were also presented in a graph

showing the proportions of hospitalisation for each group, which provided a visual representation of the differences in hospitalisation rates.

2.7.2 Objective 2: Estimation of the average hospitalisation cost of T2DM beneficiaries on DMP and those not in 2019.

Variables:

The variables used to process this objective were the year, DMP status, hospitalisation indicator and overall hospitalisation costs.

Beneficiary Categorisation:

Beneficiaries were first grouped into two categories: those enrolled in the DMP and those not. Within each DMP status group, beneficiaries were further categorised based on whether they were hospitalised. This categorisation allowed for a detailed comparison of hospitalisation costs between DMP enrolees and non-enrolees. While hospitalisation costs were not used to categorise beneficiaries, these costs represented the primary outcome as a comparison between the two groups.

Data Distribution:

Before conducting statistical analysis, the distribution of the hospitalisation cost data was evaluated using normality tests. The results indicated that hospitalisation costs were not normally distributed. To address this issue, Quantile-Normal plots were employed to determine an appropriate transformation that could stabilise variance and approximate normality. This transformation was essential to meet the assumptions required for parametric statistical tests, such as the independent t-test.

Hypothesis:

The hypothesis for this objective was formulated to determine whether there was a significant difference in hospitalisation costs between DMP enrolees and non-enrolees:

- Null Hypothesis (H_0): There was no statistically significant difference in the mean hospitalisation costs between T2DM beneficiaries enrolled in the DMP and those not enrolled in the DMP in 2019.

- Alternative Hypothesis (H_1): There was a statistically significant difference in the mean hospitalisation costs between T2DM beneficiaries enrolled in the DMP and those not enrolled in the DMP in 2019.

  This hypothesis was tested using an independent t-test, which compared the mean hospitalisation costs between the two groups.

  ### Independent T-Test:

  After transforming the data to approximate normality, an independent t-test (two-sample t-test) was performed to compare the average hospitalisation costs between DMP enrolees and non-enrolees. The t-test assessed whether the observed differences in mean hospitalisation costs between the two groups were statistically significant. The t-statistic was calculated using the appropriate formula for comparing two independent sample means. Below is the t-statistic formula used:

  $$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

  - $\bar{X}_1$ and $\bar{X}_2$ are the sample means for DMP and non-DMP groups, respectively.
  - s_1^2 and s_2^2 are the sample variances for each group.
  - n_1 and n_2 are the sample sizes for each group.

  ### Results Interpretation:

  The t-test results were interpreted based on the p-value. If the p-value were (less/greater) than the significance threshold of 0.05, we would [reject/fail to reject] the null hypothesis (H_0). This would indicate that the difference in average hospitalisation costs between DMP enrolees and non-enrolees was [statistically significant/not statistically significant].

If significant: We will conclude that there is a statistically significant difference in the mean hospitalisation costs between the two groups, with DMP enrolees having [higher/lower] hospitalisation costs compared to non-enrolees. The null hypothesis will then be rejected.

If not significant: We will conclude that there is no statistically significant difference in the mean hospitalisation costs between the two groups, suggesting that DMP enrollment does not significantly impact hospitalisation costs. This would mean we fail to reject the null hypothesis.

2.7.3 Objective 3: To determine the factors associated with hospitalisation for T2DM medical scheme beneficiaries

Main variables:

In the analysis of this objective, the dependent variable was hospitalisation status, coded as 0 for "Not Hospitalised" and 1 for "Hospitalised." The primary independent variable of interest was DMP enrolment status, coded as 0 for "No DMP" and 1 for "DMP."

Covariates

Additional covariates—such as age, gender, province, benefit plan, insulin use, months on DMP, and chronic conditions—were included as control variables to account for other factors that could influence hospitalisation outcomes.

Age, gender, and insulin: These variables were included based on findings from previous studies that show they are a predictor of hospitalisation. (48,49,58),

Benefit Plan: The type of benefit plan is a significant determinant of hospitalisation for T2DM patients, as demonstrated by Cheng, Wang, and Ko (2019) (71). This variable will help to evaluate how different health plans affect healthcare utilisation.

Province: Geographical variations are known to impact hospitalisations, as reported by Benson (2010) (Benson, 2010). This variable will account for regional differences in healthcare access, utilisation and impact on hospitalisation.

Comorbidities and disease-related complications: T2DM patients with comorbidities and complications are more likely to experience increased healthcare service utilisation, including frequent hospitalisations. This relationship is supported by studies by Murove and Khumalo

(2015), Cheng, Wang, and Ko (2019), Kok et al. (2021), and Naidoo et al. (2022) (9,11,20,71).

Including these variables will ensure a comprehensive analysis of factors influencing hospitalisation among T2DM patients and align with established research findings.

Statistical Analysis:

In order to evaluate the above objective, a binary logistic regression model was employed, utilising both univariable and multivariable analyses. Logistic regression is the ideal approach for handling binary outcomes and allows for the inclusion of multiple predictor variables. This made it particularly suitable for identifying the factors associated with hospitalisation.

Univariate Logistic Regression Analysis

Initially, each predictor variable was examined independently through univariate logistic regression. This involved fitting a separate model for each variable, including DMP status, age, gender, province, benefit plan, insulin use, months on DMP, and chronic conditions. The outcome variable in each case was whether the beneficiary was hospitalised. The logistic regression formula (see below) was used to quantify the effect of each predictor variable on hospitalisation.

$$\text{Logit}(P) = \beta_0 + \beta_1 X$$

Where:

- P is the probability of the outcome occurring.
- β_0 is the intercept.
- β_1 is the coefficient for the predictor variable X
- X is the predictor variable.

The key outputs or results of the univariate logistic regression (model) analysis were the odds ratios (OR) with 95% confidence intervals (CIs) and p-values. The OR indicated the strength

of association between each predictor and hospitalisation, while the CIs and p-value (set at a threshold of 0.05) determined whether the association was statistically significant. These univariate analyses provided an initial understanding of the individual relationships between the predictor variables and hospitalisation before accounting for potential confounding factors in the multivariate analysis.

Results from the univariate analyses were summarised in a table, displaying the odds ratios, p-values, and confidence intervals for each predictor variable. This table offered insights into how each factor independently affected hospitalisation.

Multivariate Logistic Regression Analysis

A multivariate logistic regression model was constructed to assess the combined effects of the predictor variables on hospitalisation. This model incorporated all relevant predictor variables simultaneously, including DMP status, age, gender, province, benefit plan, insulin use, months on DMP, and chronic conditions. The goal was to determine the individual and combined impacts of these variables while controlling for the influence of the others.

The dependent variable remained binary (hospitalised versus not hospitalised), and the logistic regression formula was applied to estimate the likelihood of hospitalisation as a function of the predictor variables. The multivariate analysis provided adjusted odds ratios, allowing for a more accurate interpretation of the factors associated with hospitalisation when considering the relationship between multiple variables.

The logistic regression formula used was:

$$\text{Logit}(P) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7$$

Where:

- P is the probability of the outcome (hospitalisation) occurring.
- β_0 is the intercept.
- $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ are the coefficients for the respective predictor variables.
- $X_1, X_2, X_3, X_4, X_5, X_6, X_7$ are the predictor variables.

The results of the multivariate logistic regression were interpreted by examining the odds ratios for each predictor variable, which reflected the change in the likelihood of hospitalisation associated with each factor. The p-values for each coefficient were used to assess the statistical significance of the relationships. A p-value of less than 0.05 indicated a significant association between the predictor variable and hospitalisation.

The findings from both the univariate and multivariate analyses were presented side by side in a table. This allowed for a direct comparison of the results, including the odds ratios, p-values, and confidence intervals for each predictor variable. By presenting the univariate and multivariate results together, the table offered a comprehensive view of how each factor influenced hospitalisation among T2DM beneficiaries, both individually and in combination with other variables.

2.8 Ethical Consideration

Ethical approval for this study was obtained from the Human Research Ethics Committee at the University of the Witwatersrand. Ethical clearance number for this number: M230257 MED23-02-016). After obtaining ethical approval, a request for data access was submitted to the medical scheme's ethics committee and was supported by an ethics clearance certificate. The beneficiary's confidentiality was maintained by de-identifying all personal information in the dataset. The data was stored securely and accessed only by the researcher involved in the study.

CHAPTER 3: RESULTS

3.1 Introduction

This chapter presents the main results according to the study objectives. Tables and graphs are used to illustrate a descriptive summary of the study participants stratified by DMP enrolment status across various variables. Finally, the findings of the univariate and multivariate analysis for objective 3 are presented as adjusted and unadjusted odds ratios, confidence intervals, and p-values.

3.2 Descriptive beneficiaries of type 2 diabetes mellitus

Table 3 provides a detailed description of T2DM beneficiaries. The study population comprised 120 081 beneficiaries, 23.73% enrolled in a DMP and 76.3% not. The majority of beneficiaries (both DMP enrolees and non-enrolees) fell within the age range of 50-64. The gender distribution was predominantly male (53,98% from DMP enrolees and 56,67% from non-DMP enrolees). Significant provincial variations were noted, with higher DMP enrolees observed in KwaZulu-Natal, Gauteng, and the Western Cape. The data also reflect notable differences in hospitalisations, insulin use, benefit plans, and chronic conditions.

Table 3:Descriptive summary of the beneficiaries

	DMP	No-DMP	p-value
Sample size (n, %)	28 498 (23,73)	91 583 (76,27)	
Characteristics	Frequency (%)		
Age band			
18-34	826 (3)	2 646 (3)	<0.001
35-49	5 939 (21)	18 144 (20)	
50-64	11 288 (40)	36 193 (40)	
65-79	9 060 (32)	28 851 (32)	
80+	1 385 (5)	5 749 (6)	
Gender			
Male	15,384 (53,98)	51,904 (56,67)	<0.001
Female	13,114 (46,02)	39,679 (43,33)	
Province			
KwaZulu-Natal	11 122 (39,03)	21 323 (23,28)	<0.001
Gauteng	8 637 (30,31)	34 971 (38,19)	
Western Cape	4 894 (17,17)	19 010 (20,76)	
Eastern Cape	2 123 (7,45)	4 235 (4,62)	
Mpumalanga	651 (2,28)	3 337 (3,64)	
North West	403 (1,41)	3 021 (3,30)	
Free State	297 (1,04)	2 769 (3,02)	
Limpopo	260 (0,91)	1 416 (1,55)	
Northern Cape	106 (0,37)	1 488 (1,62)	
Hospitalisation Indicator			
Hospitalised	8 716 (30,58)	29 781 (32,52)	<0.001
Not hospitalised	19 782 (69,42)	61 802 (67,48)	
Insulin Indicator			
Not on insulin	15 061 (52,85)	52 185 (56,98)	<0.001
On insulin	13 437 (47,15)	39 393 (43,02)	
Benefit Plan			
Low Day-to-Day	12 713 (44,61)	41 323 (45,12)	<0.001
High Day-to-Day	6 608 (23,19)	14 659 (16,01)	
PMB Day-to-Day	6 435 (22,58)	24 321 (26,56)	
Network	2 742 (9,62)	11 279 (12,32)	
No. of additional chronic conditions*			
1	4 929 (17,30)	5 935 (6,48)	<0.001
2	13 711 (48,11)	57 699 (63,00)	
3	9 858 (34,59)	27 949 (30,52)	
Median (IQR)			
Total Inpatient Days	3.50 (1.50-8.00)	4.00 (2.00-9.00)	<0.001
Overall Admission Costs	47 428	52 465	<0.001
(for those admitted)	(22 521 -105 564)	(24 436-124 381)	

*The number of chronic conditions that beneficiaries have in addition to T2DM.

3.3 Objective 1: Estimate the proportion of T2DM hospitalisation on T2DM medical scheme beneficiaries per DMP enrolment status in 2019

Figure 1 compares hospitalisations between DMP enrolees and non-enrolees. Our study's null hypothesis stated that there is no difference in hospitalisations between DMP enrolees and non-enrolees. However, we found that the hospitalisation for DMP enrolees was significantly ($p<0,01$) lower than for non-enrolees. DMP enrolees had a hospitalisation rate of 30.58% (8 716), which was 1.98% lower than non-enrolees. Based on these results, we thus reject the null hypothesis, as the proportions of hospitalisation are different between the two groups.

In addition to lower hospitalisation rates, DMP enrolees spent 0.5 fewer inpatient days ($p < 0.001$) than non-enrolees, as shown in Table 3. Specifically, DMP enrolees had a median of 3.5 inpatient days, whereas non-enrolees had a median of 4.0 days.

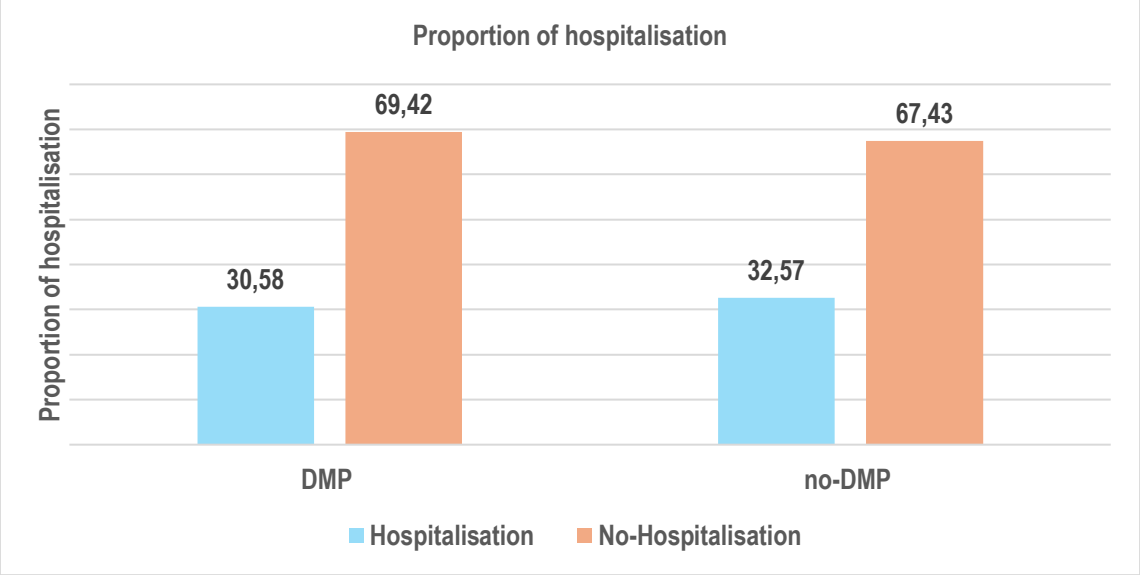

Figure 1: Proportion of hospitalisation in DMP enrolee and non-enrolees

3.4 Objective 2: Estimate of the average hospitalisation cost of T2DM beneficiaries per DMP status in 2019

Figure 2 shows the average hospitalisation costs for T2DM beneficiaries per DMP enrolment. Our null hypothesis stated that there is no difference in average hospitalisation costs between DMP enrolees and non-enrolees. However, we found that the average hospitalisation costs for DMP enrolees were significantly ($p<0,01$) lower than for non-enrolees. Those on the DMP

incurred an average cost of ZAR 55 492, resulting in hospitalisation costs of approximately ZAR 483 million for the 8 716 DMP enrollees. In contrast, non-enrollees incurred an average cost of ZAR 61 267, resulting in hospitalisation costs of approximately ZAR 1 825 billion for the 29 781 non-enrollees, a difference of ZAR 5 775 per beneficiary. Therefore, we reject the null hypothesis, as the average hospitalisation costs are different between the two groups.

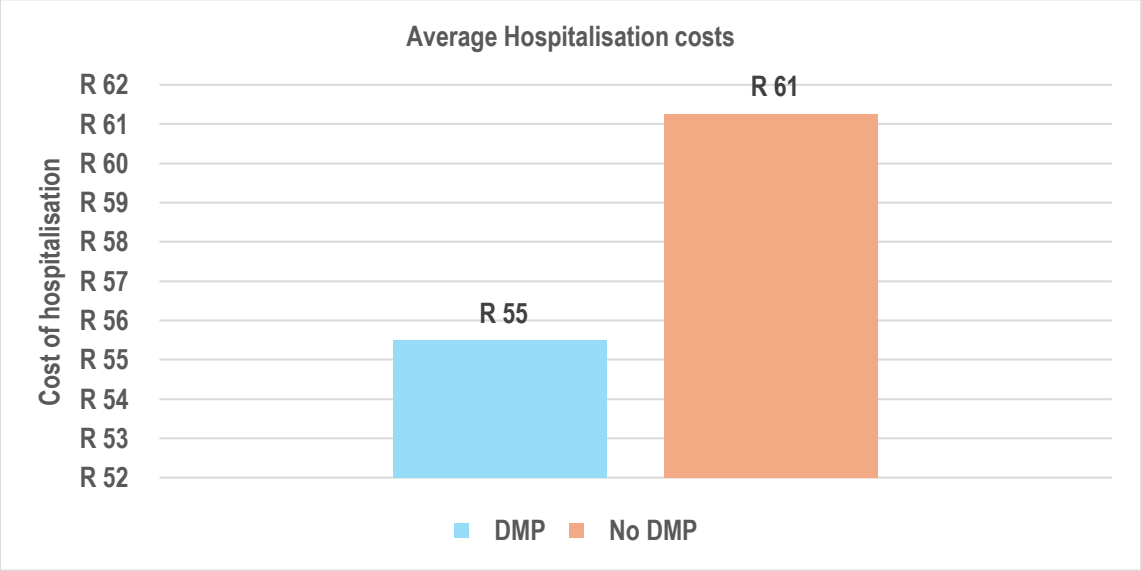

Figure 1: Average hospitalisation costs by DMP enrolment

3.5 Objective 3: Factors associated with hospitalisation among T2DM medical scheme beneficiaries in 2019.

Table 4 presents the findings from both univariate and multivariate logistic regression analyses assessing the factors associated with hospitalisation among T2DM beneficiaries within medical schemes in 2019. The analysis revealed that enrollment in DMPs was significantly associated with a reduction in the odds of hospitalisation. Specifically, beneficiaries enrolled in DMPs exhibited 8.5% lower odds of hospitalisation compared to non-enrolees, as indicated by an unadjusted Odds Ratio (OR) of 0.915 (95% Confidence Interval [CI]: 0.888-0.943, $p < 0.001$). Although the protective effect of DMP enrollment was slightly reduced in the multivariate analysis, it remained statistically significant, with an adjusted OR of 0.944 (95% CI: 0.863-1.031, $p < 0.001$), corresponding to a 5.6% reduction in the odds of hospitalisation after controlling for other covariates.

Age and gender emerged as a statistically significant predictor of hospitalisation. The odds of hospitalisation increasing by approximately 1.8% per additional year of age. This relationship

was consistent in both univariate and multivariate models, with the adjusted analysis yielding an OR of 1.020 (95% CI: 1.017-1.019, $p < 0.001$), highlighting the age-dependent odds of hospitalisation among T2DM beneficiaries. With to gender, female beneficiaries demonstrated higher odds of hospitalisation compared to their male counterparts. The unadjusted OR for females was 1.084 (95% CI: 1.058-1.111, $p < 0.001$), indicating 8.4% increased odds of hospitalisation. This association persisted in the multivariate analysis, although slightly decreased, with an adjusted OR of 1.070 (95% CI: 1.042-1.099, $p < 0.001$), indicating 7% higher odds of hospitalisation for females.

The type of healthcare benefit plan was another significant determinant of hospitalisation. Beneficiaries with high day-to-day benefit plans had 41.8% higher odds of hospitalisation compared to those with network plans in the univariate analysis (OR = 1.418, 95% CI: 1.370-1.460, $p < 0.001$). However, this association did not retain significance in the multivariate analysis (Adjusted OR = 1.010, 95% CI: 0.977-1.045, $p < 0.001$). PMB day-to-day plans also showed increased odds of hospitalisation in both univariate (OR = 1.165, 95% CI = 1.119-1.212, $p < 0.001$) and multivariate analyses (Adjusted OR = 1.137, 95% CI = 1.015-1.274, $p < 0.001$), corresponding to a 16.5% and 13.7% higher risk, respectively. After adjusting for confounding factors, the Network Benefit Plan continued to be associated with a 24.3% reduction in the odds of hospitalisation.

Geographical location further influenced the odds of hospitalisation, with notable regional disparities. Beneficiaries residing in KwaZulu-Natal and Free State had significantly higher odds of hospitalisation compared to those in Gauteng. The multivariate analysis revealed that the odds ratios for KwaZulu-Natal and Free State were 1.188 and 1.264, respectively ($p < 0.001$ for both), indicating 18.8% and 26.4% higher odds of hospitalisation in these provinces.

The presence of additional chronic conditions and insulin use were identified as strong predictors of increased hospitalisation odds. Beneficiaries with three or more additional chronic conditions demonstrated markedly elevated odds of hospitalisation, with an unadjusted OR of 3.044 (95% CI: 2.960-3.130, $p < 0.001$). This association remained highly significant in the multivariate model, although slightly reduced, with an adjusted OR of 2.140 (95% CI: 2.076-2.207, $p < 0.001$), corresponding to a 114% increase in the odds. Similarly, insulin use was associated with a substantial increase in the odds of hospitalisation, with an unadjusted OR of 2.598 (95% CI: 2.534-2.663, $p < 0.001$) and an adjusted OR of 2.375 (95% CI: 2.313-2.437, $p < 0.001$), reflecting a 159.8% and 137.5% increase in the odds of hospitalisation, respectively.

Table 4: Factors associated with hospitalisation in 2019

	Univariate analysis		**Multivariable analysis**	
Variables	Unadjusted OR (95% Cl)	P-value	Adjusted OR (95% Cl)	P-value
DMP status				
no-DMP				
DMP	0.915 (0.888-0.943)	P<0.001	0,944 (0.863-1.031)	P<0.001
Age	1.018 (1.019-1.021)	P<0.001	1.020 (1.017-1.019)	P<0.001
Gender				
Male				
Female	1.084 (1.058-1.111)	P<0.001	1.070 (1.042-1.099)	P<0.001
Benefit plan				
Low day-to-day				
High day-to-day	1.418 (1.37-1.46)	P<0.001	1.010 (0.977-1.045)	P<0.001
PMB day-to-day	1.165 (1.119-1.212)	P<0.001	1.137 (1.015-1.274)	P<0.001
Network	0.922 (0.890-0.955)	P<0.001	0.757 (0.727-0.788)	P<0.001
Province				
Gauteng				
Western Cape	1.025 (0.991-1.061)	P<0.001	1.057 (1.019-1.097)	P<0.001
Northern Cape	0.992 (0.890-1.104)	P<0.001	1.137 (1.014-1.274)	P<0.001
Mpumalanga	0.998 (0.931-1.070)	P<0.001	1.144 (1.062-1.231)	P<0.001
Limpopo	0.905 (0.813-1.01)	P<0.001	1.016 (0.908-1.138)	P<0.001
Eastern cape	0.855 (0.807-0.907)	P<0.001	0.902 (0.848-0.960)	P<0.001
KwaZulu-Natal	1.136 (1.101-1.173)	P<0.001	1.188 (1.148—1.230)	P<0.001
Free state	1.238 (1.147-1.336)	P<0.001	1.264 (1.166-1.371)	P<0.001
North West	1.125 (1.045-1.211)	P<0.001	1.222 (1.130-1.321)	P<0.001
Number of additional chronic conditions				
0				
1	1.095 (1.064-1.129)	P<0.001	1.022 (0.991-1.054)	P<0.001
2	1.412 (1.373-1.452)	P<0.001	1.174 (1.140-1.209)	P<0.001
3	3.044 (2.960-3.130)	P<0.001	2.140 (2.076-2.207)	P<0.001
Insulin				
Not on insulin				
On insulin	2.598 (2.534-2.663)	P<0.001	2.375 (2.313-2.437)	P<0.001

CHAPTER 4: DISCUSSION

4.1 Overview

This study compared hospitalisations and costs between T2DM medical scheme beneficiaries enrolled in a DMP and non-enrolees. The findings are essential for the medical scheme to make informed investment decisions, particularly in justifying the ongoing support of DMPs as healthcare expenditures continue to rise. This study contributes to the ongoing assessment of DMPs within the medical schemes industry. The findings align with a growing body of literature demonstrating the benefits of DMPs on both clinical outcomes, such as hospitalisation and healthcare costs.

4.2 Hospitalisations and Hospital Days

The findings of this study reveal that DMP enrolment is associated with lower hospitalisations. Specifically, hospitalisations for DMP enrolees were 1.9% lower, with fewer in-patient days compared to non-enrolees, indicating that DMPs are associated with reduced hospitalisations. This outcome is consistent with several studies that highlight the effectiveness of DMPs in reducing hospitalisations. For instance, Riedl et al. (2016) (58)) reported lower hospitalisations among DMP participants compared to the control group. Additionally, participants demonstrated a reduction in cumulative hospital days, further supporting the trend of fewer hospitalisations associated with DMPs.

Similarly, Hamar et al. (2015) (49)) found that patients enrolled in DMPs, experienced significant reductions in bed days, readmissions, and hospital admissions over a four-year period, suggesting that DMPs improve patient outcomes and reduce healthcare resource utilisation. A study by Smith et al. (2021) (48)) also demonstrated that DMPs resulted in significant reductions in hospital admissions, leading to fewer complications and hospitalisations.

In South Africa, a study by Distiller et al. (2010) (54)) also found that participation in a DMP was associated with reduced hospitalisations over a 5-year period. These reductions in hospitalisation days align with the findings of this study, which showed that DMP enrolees have lower hospitalisation rates and spend fewer days in the hospital compared to non-enrolees.

4.3 Hospitalisation Costs

The analysis revealed that DMP enrolees in my study had an average hospitalisation cost of ZAR 55,492, which was ZAR 5,775 lower than that of non-enrolees, supporting the financial benefits of DMPs in reducing healthcare costs. This is consistent with the findings of Riedl et al. (2016) (58) and Hamar et al. (2015) (49), who also reported that DMPs lower healthcare costs through reduced hospitalisations and improved care coordination, highlighting the financial sustainability of these programs."

In this study, the hospitalisation costs for the medical scheme differed notably between the two groups. Hospitalised DMP enrollees (n=8 716) incurred a total of ZAR 483 million in hospitalisation costs, while hospitalised non-enrollees (n=29 781) incurred ZAR 1.825 billion. This substantial difference in costs underscores the financial impact of DMPs in managing T2DM beneficiaries' health outcomes, primarily by reducing the frequency and severity of hospitalisations.

In this study, the total hospitalisation costs for the medical scheme were notably different between the two groups. Hospitalised DMP enrollees (n=8 716) incurred a total of ZAR 483 million in costs, while hospitalised non-enrollees (n=29 781) incurred ZAR 1.825 billion. This substantial difference in costs highlights the financial impact of DMPs in managing T2DM beneficiaries' health outcomes, primarily through reducing the frequency and severity of hospitalisations.

These findings underscore the financial value of investing in DMPs, which not only lower hospitalisation costs but also reduce the overall financial burden on the medical scheme. Effective disease management, patient education, and preventive care contribute to this cost reduction by decreasing the need for acute hospital interventions. The significant cost savings demonstrate the potential return on investment, advocating for the continued and expanded implementation of DMPs to create a more sustainable and efficient healthcare system.

4.4 Factors Associated with Hospitalisation

The study identified several key factors influencing hospitalisation among T2DM beneficiaries. It found that enrollment in Disease Management Programs (DMPs) was significantly associated with lower hospitalisation rates compared to non-enrolees. This finding is consistent with studies by Hamar et al. (2015) (49), Riedl et al. (2016) (58), and Smith et al. (2021) (48) which demonstrated that patients enrolled in DMPs experienced

significant reductions in bed days, hospital readmissions, and overall hospitalisations. These findings support DMP's stated claims in disease management, preventive care, and patient education. These all lead to improved management of chronic conditions like T2DM, ultimately contributing to a reduction in hospital-related outcomes.

Khalid et al. (2014) (15) found that the risk of diabetes-related hospitalisation increased with age and female gender. Similarly, this study identified that an addition in age and being female were significantly associated with higher odds of hospitalisation among T2DM patients. These factors likely reflect the complexity and progression of the disease, where older patients and females, potentially due to differences in disease management and biological responses, face higher hospitalisation risks.

Moreover, the study found that the presence of additional chronic conditions significantly increases the odds of hospitalisation among T2DM patients. This aligns with previous research by Murove and Khumalo (2015) (20), Kok et al. (2021) (9), and Naidoo et al. (2022) (11) , who reported that healthcare costs, including hospitalisation, are considerably exacerbated by the presence of disease-related complications and comorbidity. These complications often require more intensive medical intervention, leading to higher healthcare service utilisation. Multiple chronic conditions not only worsen disease management but also heighten the risk of acute events that result in increased hospital admissions and, consequently, greater financial burdens on patients and healthcare systems.

Regional variations in hospitalisation odds were also observed in the study, which is consistent with findings by Ng et al. (2010) (27), where geographical variations were highlighted as significantly associated with an increased likelihood of hospitalisation for individuals with Type 2 Diabetes. These variations often stem from differences in healthcare access, local healthcare resources, and socioeconomic disparities across regions. In areas with fewer healthcare facilities or limited access to primary care and preventive services, patients are more likely to experience complications that require hospitalisation.

Additionally, this study found that belonging to certain benefit plans is significantly associated with hospitalisation odds among T2DM patients. Specifically, being in a benefit plan outside of a managed care network was associated with higher hospitalisation rates, suggesting that coverage limitations in these plans may restrict access to essential disease management and preventive services. On the other hand, network plans, which typically provide more comprehensive care options, are associated with lower hospitalisations. This

relationship is supported by research by Wang et al. (2010) (72), which demonstrated that insurance scheme plans significantly influence medical outcomes, showing higher direct medical costs for T2DM patients in less comprehensive plans due to increased complications and hospitalisation risks.

Insulin use was also found to be strongly associated with hospitalisation, with an odds ratio of 2.375 (2.313-2.437). This indicates that T2DM patients on insulin therapy are more than twice as likely to be hospitalised compared to those not using insulin. This is likely due to the advanced nature of their disease and the complications that often accompany insulin use. Wang et al. (2010) (72) and Khalid et al. (2014) (15) also found that insulin therapy was significantly associated with higher annual direct medical costs, which aligns with our findings on increased hospitalisation risks. This suggests that the severity of diabetes, as indicated by insulin use, necessitates more frequent hospital care, driving up both medical costs and the likelihood of adverse health outcomes.

4.5 Limitations

Despite the valuable insights provided by this study, several limitations should be acknowledged:

The study relied on secondary data, which inherently limited control over the data collection process. Since secondary data is typically collected for purposes other than the specific research question, there is a possibility of inaccuracies or omissions in the dataset. These limitations can affect the quality and completeness of the information, which may, in turn, influence the validity of the study's findings. Furthermore, secondary data may lack important variables or details that are relevant to the study, such as lifestyle factors, detailed clinical histories, or socioeconomic information, all of which could potentially influence hospitalisation rates and costs.

The study employed a cross-sectional design, which allowed for a snapshot comparison of hospitalisation rates between T2DM beneficiaries enrolled in the Disease Management Program (DMP) and those not enrolled. While this design is useful for providing a quick comparison at a specific point in time, it has notable limitations. A major limitation of this design is that it does not capture changes over time, meaning it cannot establish temporal relationships or assess how DMP enrollment may influence hospitalisation rates over a longer period.

A prospective cohort study would have been ideal for tracking individuals over time, allowing for a deeper understanding of how DMP enrollment affects hospitalisation outcomes. While cohort studies can suggest associations between exposures (such as DMP enrollment) and health outcomes (such as hospitalisation rates), they cannot definitively establish causal relationships. However, they would have provided stronger evidence of the relationship between DMP participation and hospitalisation outcomes over time, better capturing the progressive aspect of these events.

Additionally, the study did not utilise detailed patient-level data, which would have been valuable for a more comprehensive analysis of hospitalisation outcomes. Patient-level data could have included specific information on treatment adherence, comorbid conditions, and other individual health factors that might have influenced hospitalisation rates, date joined DMP of data enrollment. Without this data, the study could not explore the full range of variables that might affect hospitalisation outcomes, making it more challenging to draw conclusions about the true impact of DMP enrollment on health outcomes.

CHAPTER 5: RECOMMENDATIONS

Based on the findings of this study, several key recommendations can be made to enhance Disease Management Programs (DMPs) for (T2DM beneficiaries, with the goal of improving health outcomes and reducing hospitalisation costs.

One key recommendation is to improve targeted enrollment strategies to increase beneficiary participation in the DMP. This can be achieved through a variety of communication channels available to medical schemes, including telephonic outreach, online tools and period communications sent to members. Hamar et al. (2020) (49) demonstrated that telephonic nurse outreach, which provides individualized health education and support, resulted in reduced hospital days and associated costs. Such strategies could encourage beneficiaries who might not actively seek care to engage with the DMP, ultimately improving their health outcomes and reducing hospitalisation rates.

The study revealed that the DMP analysed in this study did not specifically evaluate whether it followed evidence-based clinical process indicators such as HbA1c tests, renal function tests, eye examinations, and lipid profile tests. These markers are critical for monitoring and managing T2DM effectively as demonstrated by Erzse et al., (2019) (14). To address this gap, a policy option could require DMP providers contracted with medical schemes to report on adherence to these clinical process indicators as a condition for continued financial contracting. Routine quality audits should be mandated to verify the regular monitoring of these indicators, ensuring that beneficiaries receive care aligned with evidence-based guidelines and best practices. This would promote accountability and encourage continuous quality improvement in the management of T2DM.

Another recommendation is to integrate gender-specific and age-specific strategies within the DMP as gender and age impact on hospitalisation as indicted by Khalid et al. (2014) (15). Gender-specific interventions could address these disparities, such as providing education and support tailored to the unique needs of female beneficiaries, particularly around issues like reproductive health and diabetes-related complications. This approach could enhance engagement and improve health outcomes for female beneficiaries. Additionally, older beneficiaries, with different healthcare needs compared to younger ones, would require targeted interventions, such as more frequent check-ups and specialized educational resources tailored to the elderly, to improve outcomes for older patients, particularly those with multiple comorbidities (73). Similarly, young beneficiaries could be supported with strategies that are

promote long-term adherence to diabetes management practices using channels that appeal to them.

The socioeconomic status (SES) of T2DM beneficiaries is another crucial factor that could influence their enrollment to DMP and hospitalisation outcomes. Hill-Briggs et al. (2020) (74) found that lower SES is a strong predictor of poor health outcomes, particularly for chronic conditions like diabetes. To address this, a policy option should consider socioeconomic factors faced by populations with lower SES to inform tailored interventions (Trimpet et al., 2019) considering the diverse linguistic and cultural context of South Africa, which has nine official languages (75) These interventions should aim to mitigate socioeconomic barriers, such as offering culturally sensitive communication and addressing challenges related to transport and health literacy.

Finally, to address the endogeneity introduced by insulin use, which complicates the interpretation of its effect on hospitalisation outcomes, as demonstrated by Khalid et al. (2014) (15) and Wang et al. (2010) (72), future research should consider employing methods such as instrumental variable analysis or propensity score matching. Endogeneity occurs when the effect of an independent variable on a dependent variable is biased due to omitted causes, making interpretation difficult as defined by Cooper et al., (2020) (76). These techniques are used to adjust for confounding factors due to insulin for example and leading to more accurate estimates (77). Additionally, a policy option could involve emphasise the monitoring and management of insulin use, including ensuring adherence to treatment protocols and optimizing insulin therapy, to reduce complications and hospitalisations as per treatment guideline (14). This policy would aim to improve patient outcomes and reduce healthcare costs for T2DM management.

By implementing these recommendations and refining the DMP based on the study's findings, the medical scheme can improve patient outcomes, reduce hospitalisations, and enhance the overall effectiveness and sustainability of their programs and contracting with DMP providers

CHAPTER 6: CONCLUSION

The findings of this study highlight the significant benefits of Disease Management Programs (DMPs) for Type 2 Diabetes Mellitus (T2DM) beneficiaries, particularly in reducing hospitalisation rates and associated costs. This evidence emphasises the value of continuing investment in and utilisation of DMPs within the medical scheme.

The study was driven by the need to present evidence to justify ongoing support for DMPs. The data provided not only supports the effectiveness of DMPs in improving clinical outcomes (reduced hospitalisations) and reducing costs but also reinforces their importance as a strategic investment for the medical scheme. With healthcare expenditures rising and impacting premium costs, this study's findings offer critical insights for evidence-based decision-making and resource allocation, ensuring that DMPs remain a valuable component of chronic disease management.

CHAPTER 7: REFERENCE LIST

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APPENDICES

Plagiarism Declaration Report

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I, Thulisile Busisiwe Noutchang (Student number: 1737058), am a student registered for CD the degree of Master of Public Health in the academic year of 2024.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.

- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.

- I have followed the required conventions in referencing the thoughts and ideas of others.

- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: _____ Date: ___23/08/2024_____