Journal of Medicine, Nursing & Public Health

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ISSN: 2706-6606

Stratford Peer Reviewed Journals and Book Publishing
Journal of Medicine, Nursing and Public Health
Volume 7||Issue 3||Page 1-11|| November |2024|
Email: info@stratfordjournal.org ISSN: 2706-6606

Evaluation of Prediabetes Dietary Care Strategies, Glycemic Monitoring and Patient Glycemic Outcomes: Insights from Healthcare Providers

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***How to cite this article*: Chepngetich, I., Ngala, S., & Andago, A. (2024). Evaluation of Prediabetes Dietary Care Strategies, Glycemic Monitoring, and Patient Glycemic Outcomes: Insights from Healthcare Providers.** ***Journal of Medicine, Nursing and Public Health, 7*(3), 1–11. https://doi.org/10.53819/81018102t7037**

Abstract

Prediabetes is a condition which precedes Type 2 Diabetes. Effective strategy used in its management as well as correct glucose monitoring are key in ensuring optimum care among patients. These ensure better outcomes of care and reduced health complications. The study aimed to evaluate the dietary prescription strategies used by different healthcare providers as well as explore the use of blood sugar monitoring devices and the patient outcomes as reported by the healthcare providers. The study employed a cross-sectional design conducted in healthcare facilities across Ainamoi Subcounty, Kenya. Structured questionnaires were administered to 150 healthcare providers, collecting data on their sociodemographic characteristics, approaches to diabetes care, access to blood sugar monitoring devices as well as patient care outcomes. Data was analyzed using SPSS Version 20, utilizing descriptive statistics and chi-square tests. The findings revealed that 16.7% of participants were nutritionists, 19.3% medical officers, 20% clinical officers, 36.7% nurses, and 7.3% community health promoters. Gender and education level were significantly associated with the healthcare cadre ($p<0.001$), and access to glucometers varied significantly by cadre ($p=0.004$). More than 60% of healthcare providers across all cadres reported patient progression to Type 2 diabetes. The study concluded that all healthcare cadres play a critical role in prediabetes care and individualization of care as well as the use of low carbohydrate diet may help normalize plasma glucose levels among prediabetes patients. Blood sugar monitoring should therefore be emphasized, including adoption of advanced methods like continuous glucose monitoring. The study recommended targeted training for healthcare providers across all cadres on standardized care strategies, improved access to blood sugar monitoring tools, and the integration of technology to support patient management.

Keywords: *Glucometer, glycemic outcomes, strategy of care, diabetic diets, continuous glucose monitors.*

1.0 Introduction

Prediabetes which is a condition preceding Type II Diabetes, is considered the highest risk factor for the development of Type II Diabetes and is characterized by blood sugar levels between 5.4 mmol/l and 6.9 mmol/l. It is in itself increasing worldwide with more than 47 million people expected to be having it by the year 2030 [1]. In Kenya, the prevalence of Pre-diabetes stood at 3.1% according to the same report. The prevalence of undiagnosed diabetes in Kenya was reported to be 52.8% in an earlier report [2]. Higher rates of almost 40% had even been recorded among rural Western Kenya which is alarmingly way above the national average, also 14.2% prevalence rate was reported in Central Kenya [3]. Several components are required for successful diabetes care. Apart from the active participation of the person living with diabetes, integration of interprofessional` team is an invaluable input coupled with complete and efficient information sharing within this team which should focus on Chronic Care Model(CCM) of management [4]. In most countries, dieticians play a major role in MNT in Diabetes, with their main focus being lifestyle changes in terms of weight management, dietary modifications as well as adherence counselling [5]. Similarly, in some countries, especially where there is shortage of specialized HealthCare workers; dieticians and diabetologist, general practitioners and even nurses can actively be involved in dietary management of diabetes even in the Primary healthcare set up where even the Community Health Promoter (CHPs) can take this role [6]–[9].

Another critical aspect in diabetes care is glycemic monitoring at the healthcare facilities and home for this largely contribute in better monitoring of plasma glucose to evaluate effectiveness of care provided to the patient [10]. Healthcare workers are therefore, supposed to be in a position to check glycemic levels of their patients whenever they need to by use of sugar monitoring devices which have been reported to effectively monitor this. These include glucometers which have long been used by healthcare providers and even by patients while they practice self-care in the aspect of diabetes management [11], and continuous glucose monitors which have been shown to be an excellent glycemic response monitoring device that checks intra- and inter-day glycemic excursions that may lead to acute events (such as hypoglycemia) or postprandial hyperglycemia [12]. Effective strategies of care need to be used by healthcare provider every time they provide services to a diabetic patient. Individualized nutrition is being adapted in care of patients because, response to a given intervention varies from one person to another [13]. In fact, in nutrition care the best diet for a patient is that which works for them. This is because, individual's genotypic and phenotypic characteristics are varied especially with the environmental effect [14]. We however have other care strategies like group education and peer-peer sessions which have traditionally been used for behavior change in most social aspects [15]. Nutrition intervention too, is a social aspect as it involves, to a greater extent the aspect of behavior changes from the usual dietary lifestyle to modified dietary aspects, hence the use of these two strategies is also valid in this context.

Whenever a strategy has been used in care, a healthcare provider expects to see changes. In diabetes care the key outcome measure is plasma glucose level. In most cases more than 10% of the patients diagnosed with prediabetes progress to Type II Diabetes annually (Tabak, et al 2012), with up to 70% of them eventually developing diabetes (Tseng, et al.,2017), posing a series of comorbidities, complications and increased cost of disease management.

Diet therapy remains a key modifiable element in the management and even remission of Type II Diabetes and prediabetes when it comes to Medical Nutrition Therapy (MNT) of T2DM and prediabetes[16]–[18]. Consequently, there is notably an emergence of so many diet regimes which have been widely adapted in the developed countries, for instance, Mediterranean diet, low carbohydrate diets, vegan, vegetarian diet among others [19]–[22]. The adoption of these diets by the healthcare providers in their day to day practice varies widely.

The healthcare providers' specialty may influence the strategy used, the diet prescribed and even the outcome of care which can be ascertained by monitoring plasma glucose using appropriate devices. It is therefore against this backdrop was this study carried out.

1.1 Objectives of the Study

i. To determine the sociodemographic characteristics of the prediabetes care providers in Ainamoi Sub county.

ii. To determine the access and usage of blood sugar monitoring devices by healthcare provers and patients.

iii. To evaluate the strategy of care used by healthcare providers in prediabetes care

iv. To determine the outcome of care reported by healthcare providers and the diet attributed to the outcome.

2.0 Research Methodology

The study was conducted in Ainamoi sub-county (0°18′S 35°17′E / 0.3°S 35.28°E / -0.3; 35.28) situated in Kericho county. The sub-county was purposively sampled owing to the fact that it was the most urbanizing sub-county in this region, predisposing its population to the risk factors of developing type 2 diabetes and prediabetes. The study utilized cross-sectional study design which was facility based. Level two to level five facilities were purposively sampled in this study owing to the fact that advanced diagnostic services and care on diabetes may be available in these facilities, as opposed level 1 facilities which were excluded. The role of nurses, medical officers, nutritionists and clinical officers in these health facilities is key in prediabetes care, however, the community health promoters(CHPs) have recently been empowered in Kenya to provide basic interventions in the community in many aspects of lifestyle diseases [23],which prompted their inclusion in this study. The study participants were conveniently sampled from these facilities because of their demanding work hence had very limited time to participate in the study This therefore allowed feasibility of the study and improve the response rate especially with the shift working schedule.

Sample size and Data collection procedures

Based on Fischer's formula, sample size calculation and adjustment for 288 healthcare workers was done. The calculated sample size therefore was 165. A request to specific departments in the respective facilities was put forth. The healthcare providers who accepted and consented were conveniently sampled and interviewed at their respective work stations. This study eventually utilized data from 150 respondents who managed to complete the study.

Data was collected using a pretested semi-structured questionnaire on the Open Data Kit (ODK) smartphone application, covering socio-demographic information, glucose monitoring practices, care strategies, and dietary approaches. The study was ethically approved by the University of

Eastern Africa, Baraton Institutional Ethics Committee, National Commission for Science, Technology Institute (NaCoSTI), [NACOSTI/P/23/23262] and Kericho County Referral Hospital ethical committee, with informed voluntary consent obtained from participants. Statistical analysis was conducted using SPSS version 20, employing descriptive statistics and chi-square tests to examine associations between variables and healthcare provider specialties.

3.0 Findings

3.1 Characteristics of Healthcare Providers providing Medical Nutrition Therapy for Prediabetes and New T2DM patients in Kericho County

The response rate for this study was 91%. The proportion of males among the 150 respondents was 47.3% and 52.7% were females. Majority (41.3%) were aged between 31-40 years and with slightly over a third of them were nursing officers who were the majority (36.7%), while nutritionists who took part in this study accounted for 16.7%. The highest level of education attained by most of the respondents was Diploma (42.7%). Slightly over half of the respondents (58.0%) had worked for between 1-5 years. About three quarters of the respondents had worked at level 4 facilities (74.7%) which were mainly under ministry of health (75.3%). About half of the respondents (50%)worked for more than 8 hours per day.

The study evaluated seven sociodemographic characteristics across different healthcare cadres, revealing statistically significant associations with gender and education level ($p<0.001$). Male predominance was observed among medical officers (60%), clinical officers (72.4%), and Community Health Extension Workers (81.8%), while female nursing officers (65.5%) and nutrition officers (84%) were prominent. Educational levels varied, with diploma holders predominating across most cadres except medical officers, who were primarily degree-certified. Despite no statistical significance in age, working hours, practice type, workplace, and experience, over three-quarters of respondents had worked 1-5 years in level 5 health facilities, with 72% of medical officers and Community Health Promoters working extended hours daily.

Table 1: Sociodemographic Characteristics of Healthcare providers by Cadre

Characteristic	Nutritionist n (%) 25(16.7)	Medical Officers 29(19.3)	Clinical Officers 30(20)	Nursing Officers 55(36.7)	CHPs 11(7.3)	Chi-Square P-value (n=150)
Age						0.040
20-25	4(16.0)	-	2(6.7)	11(20.0)	2(18.2)	
26-30	8(32.0)	3(10.3)	7(23.3)	10(18.2)	1(9.1)	
31-35	5(20.0)	9(31.0)	9(30.0)	6(10.9)	3(27.3)	
36-40	4(16.0)	5(17.2)	5(16.7)	15(27.3)	1(9.1)	
41-45	2(8.0)	3(10.3)	3(10.0)	5(9.1)	-	

Over 45Years	2(4.0)	9(24.1)	4(13.3)	8(10.9)	4(9.1)	
Gender						*<0.001
Male	4(16.0)	21(72.4)	18(60.0)	19(34.5)	9(81.8)	
Female	21(84.0)	8(27.6)	12(40.0)	36(65.5)	2(18.2)	
Highest Level of Education						*<0.001
Degree	11(44.0)	29(100.0)	8(23.3)	25(18.2)	-	
Higher National Diploma	-	-	10(33.4)	3(5.4)	-	
Diploma	16(52.0)	-	12(43.3)	36(65.5)	7(63.6)	
Certificate	4(4.0)	-	-	6(10.9)	4(36.4)	
Working Hours per day						0.057
Part-time	2(8)	-	-	-	-	
Full-Time	15(60.0)	8(27.6)	15(56.7)	29(54.5)	3(27.3)	
Extended Hours	8(32.0)	21(72.4)	13(43.3)	25(45.5)	8(72.7)	
Type of practice						0.839
Private/NGO	7(24.0)	5(13.8)	6(20.0)	17(25.5)	2(18.2)	
Ministry of Health	19(76.0)	25(86.2)	24(80.0)	41(74.6)	9(81.8)	
Place of Practice						0.188
Level 3	4(16.0)	2(6.9)	2(6.7)	4(7.3)	2(18.2)	
Level 4	10(40.0)	8(27.6)	10(33.3)	11(20)	4(36.4)	
Level 5	11(44.0)	19(65.5)	18(60.0)	40(72.7)	5(45.4)	
Years of Experience						0.380
Less than 1 year	3(12.0)	-	-	4(7.3)	1(9.1)	
1-5 years	14(56.0)	21(72.4)	17(56.7)	31(56.4)	4(36.4)	
6-10 years	4(16.0)	6(20.7)	7(23.3)	9(16.4)	2(18.2)	
more than 10 years	4(16.0)	2(6.9)	6(20.0)	11(20.0)	4(36.4)	

**n is 150*

All the numbers in parenthesis are frequencies.

Level 1-5, means varied places of practice depending on the services offered as par the categorization of health institutions in Kenya; from simple general to complex specialized services [24].

3.2 Blood Sugar Monitoring

The study analyzed the blood sugar monitoring devices used by healthcare providers in the clinics and by patients at home as reported by the healthcare providers. The main devices solicited to understand their access and usage were glucometers and continuous glucose monitors. The access and use of the glucometers by healthcare provider was statistical significant with the cadre (p=0.004) with more than four fifths of HCPs across all cadres accessing and using it when they needed to. The study also reports statistical significance(p=0.027) on the knowledge of CGM among HCPS with more than 60% of the respondents in each cadre mentioning to have awareness of it except majority of CHPS (81.8%) who showed low level of awareness. There was no statistical association between the cadres and the access and use of CGM (p=0.133). On the use of these devices at home by their patients, there was no statistical difference in both cases. However, over 50% of the HCPS, with the most being CHPs (77.8%) reported having their patients using a glucometer at home to monitor their blood sugar levels. A significant number of HCPS (over 20%) across all cadres never knew if their patients used glucometers at home. Additionally, none of the HCPS reported having had their patients use CGM device, albeit a few (less than 10%), who did not know if their patients used them, otherwise, more than 92% said their patients never used CGM at home, Table 2.

Table 2: Access and Use of blood sugar monitoring devices by the HCPS and their patients

Characteristic	Nutritionist	Medical Officers	Clinical Officers	Nursing Officers	CHPs	Chi-Square P-value (n=150)
Access and use of glucometer by HCP						*0.004
Yes	21(84.0)	27(93.1)	26(86.7)	49(89.1)	9(81.8)	
No	4(16.0)	2(6.9)	4(13.3)	6(10.9)	2(18.2)	
Knowledge on Continuous Glucose Monitoring						*0.027
Yes	17(68.0)	27(93.1)	24(82.8)	42(77.8)	2(18.2)	
No	8(32.0)	2(6.9)	5(17.2)	11(22.2)	9(81.8)	
Access and Use of CGM by HCP						0.133
Yes	0	2(6.9)	0	0	0	
No	25(100)	27(93.1)	30(100)	55(100)	11(100)	
Patients use of glucometer at home						0.186
Yes	15(60.0)	16(55.2)	13(63.3)	39(70.9)	7(77.8)	
No	5(20.0)	2(6.9)	2(6.7)	3(5.5)	0	
Don't Know	5(20.0)	11(37.9)	9(30.0)	13(23.6)	4(22.2)	
Patient's use of CGM at Home						0.418

No	23(92.0)	27(93.1)	27(90.0)	53(96.4)	9(77.8)
Don't Know	2(8.0)	2(6.9)	3(10.0)	2(3.6)	2(22.2)

***** *statistically significant p-value*

3.3 HCPs' Strategy of Dietary Diabetes Care, Outcome of care and diet attributed to normalization of blood sugar levels among their patients

As shown in Table 3, statistical significance was evident between applied strategy of care by healthcare workers and their respective cadre(p=0.024). However, most of HCWs embraced indidualisation of care with more than two thirds of Medical Officers embracing it more (89.7%), followed by the nutritionists (84.0%) and clinical officers (83.3%). Nurses who embraced it were two thirds (67.3%). Notably, Some of the HCPs however applied no specific strategy, especially by slightly more than a quarter of nurses (25.1%) and CHPs (36.3%).

Similarly, no statistical significance was shown between the cadres and the outcome of care (P=0.841) with majority (over 60% in each cadre) reporting that their patients progressed to developing type 2 diabetes. Slightly above a third of nutritionist (36.0%), Clinical officers (33.3%) and nurses (36.4%) reported that their patients had their blood sugar normalized when checked beyond 6 months' period. Further analysis done to ascertain the diet which HCPs mostly attributed to the normalization of blood sugar levels showed no statistical significance across cadres (P=0.923). However, low carbohydrate diet was adversely mentioned to be prescribed by more than 50% of the HCPs. The rest of the respondents, mentioned that low calorie diets were attributed to normalization. Only 3.4% of the Medical officers recognized Mediterranean diets in this context, while the rest of the Healthcare providers in the other cadres did not, Table 3.

Table 3: HCPs' Strategy of Dietary Diabetes Care, Outcome of Care and Diet Attributed to Normalization of Blood Sugar Levels Among Their Patients

Characteristic	**Nutritionist n (%) 25(16.7)**	**Medical Officers n (%) 29(19.3)**	**Clinical Officers n (%) 30(20)**	**Nursing Officers n (%) 55(36.7)**	**CHPs n (%) 11(7.3)**	**Chi-Square P-value (n=150)**
Most applied Strategy of Care						*0.024
Indidualisation	21(84.0)	26(89.7)	25(83.3)	37(67.3)	7(77.8)	
Group Education	1(4)	-	-	4(7.3)	-	
Peer-peer sessions	1(4)	1(3.4)	2(6.7)	-	-	
No-Specific Strategy	2(8.0)	2(6.9)	3(10.0)	14(25.4)	4(36.3)	
Glycemic Outcome Of dietary diabetes care						0.813
Progression to Type II diabetes	16(64.0)	22(75.9)	20(66.7)	35(63.6)	8(72.7)	
Reduction of blood sugar to normal values for a	9(36.0)	7(24.1)	10(33.3)	20(36.4)	3(27.3)	

period lasting over 6 months						
Diet Mostly Attributed to Normalization of blood sugar						0.923
Mediterranean	0	1(3.4)	0	0	0	
Low-Carbohydrate diet	15(60.0)	16(55.2)	16(53.3)	30(56.4)	6(54.5)	
Low calorie diet	10(40.0)	12(41.4)	14(46.7)	24(43.6)	5(45.5)	

**- statistically significant p-value.*

4.0 Discussion:

The sociodemographic characteristics of healthcare providers involved in prediabetes care can vary across regions. Studies have shown that primary care physicians (PCPs) who are equivalent to clinical officers and medical officers reported in this study, Nurses, Nutritionists and community health workers, play a key role in managing prediabetes, particularly in regions with high diabetes risk. In most countries, dieticians play a major role in Medical Nutrition Therapy in Diabetes, with their main focus being lifestyle changes in terms of weight management, dietary modifications as well as adherence counselling [5]. Similarly, in some other countries, dieticians and diabetologist, general practitioners and even nurses can actively be involved in dietary management of diabetes even in the Primary healthcare set up where even the CHPS can take this role [6]–[9]. Earlier study had reported that the primary care physicians in prediabetes care were largely aged above 40 years (56.3%), males(70.3%) which is similar to the findings of this study and had worked for over 10 years(62.5%) in private practice(65.6%), contrary to the findings of this study [25].

Although prevalence of CGM use has increased up to 4.1% in the year 2020, the use by HCPS in this study is comparably high especially among the medical officers, but it is still averagely low across all cadres who are significantly involved in prediabetes care [26],[27]. Another earlier study had however shown higher prevalence of use of CGM by healthcare providers 48.78%, but it was mostly used among Type 1 diabetes patients only. The access of glucometer by healthcare providers had earlier been reported by an earlier to be limited due to limited resource set-up of Kenya as country according to an earlier study [28], but the findings of this study showed higher access by HCPs. In regards to the use of glucometer by the patients at home, an earlier study had reported 73% use [29]. This finding shows some consistency to the findings of this current study. However, another recent study reported a contrary finding of patient's use of only 49% [30]. This shows disparity across regions on this aspect.

The study revealed that prediabetes patients frequently progress to type 2 diabetes, with progression rates varying across research. While Tabak et al. (2012) initially reported a 10% annual progression rate, this study and Tseng et al. (2017) observed higher rates approaching 70% [Tabak et al., 2012].

Dietary approaches for diabetes management were examined, with low-carbohydrate diets being most commonly prescribed and attributed to blood sugar normalization [14, 28]. In contrast, the Mediterranean-style diet, previously considered effective for type 2 diabetes prevention [29], was least prescribed, highlighting inconsistencies in dietary recommendations for glycemic control across different research findings.

5.0 Conclusion

The study concludes that healthcare providers across all cadres play a crucial role in managing prediabetes in order to ensure better care outcomes. The study emphasizes the importance of individualized care strategies and the need to prioritize blood sugar monitoring, particularly through the use of glucometers and where possible, continuous glucose monitoring (CGM). It also highlights the significance of dietary interventions, with low-carbohydrate diets being commonly prescribed and attributed to blood sugar normalization among prediabetes patients.

The study however notes that there could be limitations in the healthcare-reported outcome of care, especially if attributed solely to dietary care because there are other patient factors like adherence or even presence of other comorbidities that could affect the reported outcome of care.

6.0 Recommendations

The study recommends targeted training for healthcare providers across all cadres to enhance their knowledge and skills in prediabetes care and blood sugar monitoring. It also suggests improving access to blood sugar monitoring tools, particularly glucometers, and promoting the use of advanced technologies like continuous glucose monitoring (CGM). Additionally, the study advocates for the adoption of personalized care strategies, with a focus on dietary interventions such as low-carbohydrate diets, to help normalize blood sugar levels and reduce the progression to Type 2 diabetes. Integrating technology and offering continuous support through individualized care plans are key to optimizing glycemic outcomes and minimizing diabetes-related complications. Future researches focusing on the patient's perspective in these aspects are recommended.

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