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Awareness of Type 1 DM Patients about the Importance of Carbohydrate Counting and Insulin Corrective Factor in Tabuk Region, KSA 2025

Ahmad Raja Saeed Albalawi, Asma Ali Alharbi, Sarah Abdulleh Alfaer, Amal Ali Alharbi, Areej Daham Alanizi

Corresponding author: Ahmad Raja Saeed Albalawi

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ABSTRACT

Background: T1DM is a disabling chronic condition that necessitates functional approaches like CC and insulin corrective factors to achieve successful diabetes Self-Management. Thus, the degree of knowledge and usage of these practices by the T1DM patients in Tabuk, Saudi Arabia, has not been determined yet.

Objective: The objective of the present investigation was to evaluate the level of patients' knowledge about T1DM, CC and insulin corrective factors and to determine the prevalence and demographic and clinical characteristics of patients with inadequate knowledge or suboptimal practice.

Methodology: This work involved descriptive cross-sectional research and was done in Tabuk, Saudi Arabia within July-December 2024. In this cross-sectional study, 428 T1DM patients with age ≥18 from primary care clinics participated in this study based on convenience sampling. Data was obtained through interview administered questionnaires and analyzed with the assistance of statistical package for the social science (SPSS) version 26. Quantitative data was summarized using descriptive statistics while inferential statistics in form of chi-square tests were used to determine if there was significant association between two variables, at a significance level of 0.05.

Results: Out of all respondents 66% displayed awareness of carbohydrate counting methods yet only 22% put this knowledge into practice to manage their diabetes. The research showed that 93% of participants understood insulin correction factors. A higher level of education paired with continued dietitian consultations and shorter diabetes duration (less than 10 years) contributed to better awareness of the disease (288 respondents respectively). Out of 167 respondents who lacked diabetes knowledge approximately half (55 people) experienced inadequate glucose levels accordingly. Survey results demonstrated that high blood sugar frequency (HbA1c > 8.0%) affected 290 of the respondents.

Conclusion: The results suggest low knowledge and poor adherence to CC of insulin correction factors among 1TDM patients in Tabuk. This gap means that there is need to conduct more educational interventional targeted at ensuring that patients with diabetes have adequate knowledge and practice these crucial diabetes self-management behaviors. Glycemic control awareness and daily practice can help reduce complications, thus improving the life span of individual with T1DM.

Keywords: *Type 1 Diabetes Mellitus, Carbohydrate Counting, Insulin Corrective Factors, Glycemic Control, Patient Awareness, Diabetes Education*

1. INTRODUCTION

T1DM is one of the most challenging diseases that a patient can have to deal with while receiving treatment. The WDL accounts for that diabetes is one of the bigger global well-being challenges of the 21st century [1,2]. It was estimated that in 2013 the total number of people with diabetes was 382 million and forecasts showed that such rate may reach 592 million by 2035 [3]. T1DM comprises about one percent of all DM cases and it affects all age groups, although it commonly affects children or young adults. Although the specific reasons for T1DM are not unveiled currently they are presumed to be hereditary and environmental [4]. A long time period has seen the occurrence of T1DM increase in Saudi Arabia. Approximately over one-third of the 35, 480 children and young persons in Saudi Arabia were diagnosed to have T1DM by 2017, with increasing annual incidence of 3,900 instances [4,5].

CC is a primary benignant considerate approach toward enhancing glycemic outcomes in diabetic populations [6]. CHO has a critical estimation for the management of children and teenagers with T1DM to improve postprandial glycemia. Recalled by an organized diabetes schooling program, CHO enhances improved viewpoint of more immense flexibility in decisions regarding food and better glycemic control [7]. Effective diabetes the board implies wide fram reach educational intercessions with particular team recipes for healthy mediations [8]. CHO counting is normally applied to determine the prandial insulin requirements. Given that precise CHO evaluation should in theory a priori influence the extemporaneous blood glucose levels. Savvy et al's also revealed that this study clearly demonstrated that a 10g difference in CHO did not change the effects

on blood glucose or incidence of hypoglycemia but 20 g difference above or below 60 g at dinner led to hypo or hyperglycemia respectively.

Consequently, there is limited usage and analysis of CC information among the T1DM patients In Saudi Arabia. The fifth study among Middle Eastern Inlet people revealed that low nutrition knowledge of food sources containing starch [11]. In other words, a low level of awareness of the starch food sources was noted among Saudi populace [12]. The percentage focuses on assessing the data on starch considered as section of T1DM patients and links it with clinical and socio-segment factors which can influence the precision of carb appraisal.

2. Literature Review

T1DM is an autoimmune disease characterized by the permanent need for individual Glycemic Control in order to avoid both acute and chronic complications. CC and insulin corrective factors are two or the paramount tools in achieving near normal blood glucose concentrations in patients with T1DM. Even so, worldwide and regional disparities in awareness and implementation remain a challenge [1], [4] Saudi Arabia inclusive. This literature review combs the existing literature to build a broad understanding upon which the study of awareness levels amidst T1DM patients in the Tabuk region will be based on.

2.1. International Epidemiology of T1DM and Glycemic Control

T1DM impacts the lives of millions globally and has risen in incidence in the last decades [3][5]. Some investigations have highlighted the impact of organised educational interventions on the functionality of CC and insulin correction for glycemic control [7]. But differences in their use and awareness of these approaches prevailed between the countries and even within the regions [6], [8].

2.2. Carbohydrate Counting: The Importance

Carbohydrate counting is, furthermore the core of this type of therapy which involves administration of intensive insulin doses and proper glycemic regulation. Research has indicated that people who have undergone CC education have improved postprandial glucose and less HbA1c [7], [10]. Concerning the knowledge about CC in T1DM patients in Saudi Arabia, Almoamary et al documented that only 30% of the patient participants in their study scored adequately in this regard [6], [13]. Furthermore, knowledge deficits give rise to undesirable glycemic control exacerbating the occurrences of both hypoglycemia and hyperglycemia [14].

2.3. Insulin Corrective Factors

Corrective factors accompanying insulin Supply the comparable role to CC in allowing the patient to change the insulin doses built on the blood glucose levels. Studies show that integration of CC with correct insulin changes yields positive improvements to the general management of the disease [9]. However, the routine utilization of these practices seems challenging due to inadequate knowledge on these practices, particularly in the LMICs [15].

Analyzing Saudi Arabia, Regions

T1DM is more commonly seen in the Saudi population than in any other country [4]. Though all the healthcare facilities in the Tabuk region offer diabetes education it is noted that there are no specific programs for CC and insulin corrective factors. A later cross-sectional study identified significant correlations of CC knowledge with such factors as education level and the frequency of follow-up visits to dietitians [6]. In Relation to these gaps efforts to enhance glycemic control and decrease on diabetic complications in the region must be initiated.

2.4. Intervention and Future Directions

To increase patients' knowledge about CC and insulin corrective factors, more focused educational initiatives that can be implemented on a local level are required. Duration research substantiates that structured learning successful reduce the A1C assay and generally outcomes [7], [8].

3. Method

3.1. Research design

This study uses a cross-sectional survey method which adequately fits in establishing the current state of knowledge and practice of carbohydrate counting (CC) and insulin corrective factors of T1DM patients. It assesses the proportions of participant familiarity with the conditions and associates them with participant demographic and clinical characteristics. A cross sectional design is efficient in that data is collected at one time and hence one can establish the relationship between such factors such as awareness levels and factors such as glycemic control. This approach has an implication of providing insight into the development of healthcare interventions for the studied population.

3.2. Subjects and Setting

The study participants were 428 T1DM patients attending different health facilities which are located in the Tabuk region of the Kingdom of Saudi Arabia. Tabuk is a city in the north western area of Saudi Arabia and covers an area of about 11700 square kilometers. It is popular for health care, primarily care for diabetes and the ensuing education.

These healthcare facilities were selected for the study because they routinely deal with patients with T1DM. The subjects for the study were selected through nonprobability convenience sampling method, which is operational and feasible.

3.2.1. Inclusion Criteria:

1. Type 1 Diabetes Mellitus patients of eighteen years and above.

2. Aspirational patients who are willing, knowledgeable and competent to give their consent to be included in the research.

3.2.2. Exclusion Criteria:

1. Diagnosed DM-2 or other types of DM patients.

2. Patients who had declined to participate or had informed refusal to give consent for their information to be used.

This exclusion and inclusion process safeguarded the target population focus and eliminated causes of bias owing to the other types of diabetes.

3.3. Surgical Techniques

As this study is observation based and does not involve any interaction with the subjects being studied and aims at surveying level of awareness and behavioral practices; surgical procedures do not apply. However, the emphasis of the intervention is more ecological, leaving such pivotal aspects of glycemic management as carbohydrate counting and insulin corrective factor out.

3.4. Data Collection

Evidences were obtained through Survey-administered questionnaire that was professionally developed to eliciting information that are related to the theme of the study. The questionnaire had the following key sections:

1. Demographics: Age, gender, educational attainment and duration of diabetes.

2. Diabetes Management Practices: Species with and frequency of insulin use. How often follow-up visit with dietitians are conducted. Instead, clinical assessments will be focused on estimating patients' HbA1c levels as indicators of glycemic control.

3. Awareness and Practice: Awareness of carbohydrate counting: whether the participants had knowledge of the technique and their perception of the significance. Practice of carbohydrate counting: the understanding about the usage of CC and insulin corrective factors of diabetes regulation during everyday practice.

3.5. Outcome and Comorbidity Resolution

The study focused on two primary outcomes:

1. Knowledge and Practice: Percentage of participants having knowledge and appreciation of CC and Insulin corrective factors. Percentage of study participants who described their regular use of these practices in diabetes management.

2. Glycemic Control: Assessed through HbA1c level scores derived from patient's own reports; normal (HbA1c<7.0%), marginally poor (7.0%<HbA1c<8.0%), and poor (HbA1c >8.0%). As far HbA1c is concerned the awareness of this complication showed a significant association with the same.

3. Comorbidity Reduction: Understanding of CC and insulin corrective factors in relation to complications such as hypoglycemia and hyperglycemia were assessed. Further elaboration of knowledge's effect on what follows concerning general health and avoiding microvascular and macrovascular disease.

4. Statistical Analysis

Data entered and analyzed using Statistical Package for Social Science (SPSS) version 26 systematically. Analytical steps included:

1. Descriptive Statistics: The demographic data, as well as awareness level and glycemic status, were expressed in terms of frequencies and percentages. Covariates including age, gender, education, and years with diabetes were also described to present the participants' profile.

2. Inferential Statistics: Categorical data, including the education level and awareness of CC, were compared using chi-square analysis. Cross-sectional proportions and multiple regression coefficients were compared using the independent samples t-test and multiple linear regression analyses for significant relationships at $p < 0.05$.

5. Results and Analysis

This section offers a briefing of the study findings from seventy-seven patients having T1DM in the north western part of Saudi Arabia, specifically the Tabuk region, regarding their knowledge of CC and insulin corrective factors. Descriptive statistics and chi-square tests were performed to determine relationships between demographic and clinical characteristics and knowledge of CC and insulin corrective factors.

5.1. Participants' demographics

Most participants were within the 18 to 30 years age bracket (61.3%) while approximately 5.4% belonged to each between-31-and-45-years and between-46-and-60-years categories. The participants consisted of 53.3% male adults (218 individuals) who jointly shared the study with 46.7% female participants (191 individuals).

Most respondents (44.9%) stopped their education at secondary level (184 participants), yet half of the participants (34.9%) concluded their studies at primary level (143 participants). A smaller group of adults have reached university degrees (73 participants) or primary level (6 participants) education while only 3 participants completed postgraduate studies.

The majority of participants (30.1%) had been diagnosed with diabetes between 1 to 5 years (157 participants) while another large group (25.1%) had lived with the condition between 6 to 10 years (131 participants). The study results showed 25.1% of participants managed diabetes for more than 10 years and 30.1% had a 1 to 5 year diagnosis history (157 participants and 131 participants respectively). The remaining 0.4% of participants received their diagnosis less than a year ago (2 participants).

5.2. Carbohydrate Counting also known as CC

- Awareness: Over half of all 428 participants demonstrated awareness about carbohydrate counting by attaining a total of 270 among the participants. Research indicates that participants who manage their diabetes through carbohydrate counting represent only 22% (90 participants) of the total study group.

- Factors Associated with Awareness:

o Educational Level: Higher levels of education such as college/university and postgraduate allowed participants to

demonstrate greater CC awareness statistically (p = 0.03) compared to participants with lower educational attainment.

o Duration of Diabetes: Subjects who received their diabetes diagnosis one decade ago or less showed better CC technique understanding in comparison to diabetics with 10 years or longer duration (p = 0.04).

o Regular Follow-Up with Dietitians: Participants who received follow-ups with dietitians during the one to four weeks after consultation displayed better awareness of CC compared to those who did not keep regular visits (p = 0.02).

5.3. Insulin measures and their corrective factors

• Awareness: Insulin corrective factors were well known among 93% of study participants however only a minority actually modified their insulin doses properly when using these factors.

• Factors Associated with Awareness:

o Educational Level: Education levels proved substantial in selecting those who displayed improved understanding of insulin corrective factors (p = 0.01).

o Duration of Diabetes: Adults with diabetes longer than ten years displayed better knowledge of insulin corrective factors as compared to individuals with diabetes less than ten years (p = 0.07).

o Regular Follow-Up with Dietitians: People who visited a dietitian regularly exhibited a better understanding of insulin correction factors which showed statistically meaningful results (p = 0.05).

5.4. Glycemic control and its correlation to knowledge.

Results of the study indicated that inadequate knowledge about carbohydrate counting together with insulin correction factors directly correlates with poor glycemic control (p = 0.01). The participants who demonstrated thorough knowledge about CC counting and insulin corrective elements achieved superior HbA1c results when compared to those with weak understanding.

5.5. Statistical Analysis

Chi-square tests measured the association between population variables (age, education level, diagnosis duration and dietitian follow-up frequency) and CC and insulin-related knowledge in participants. Research established that people with longer education and less than ten years of diabetes duration and diabetic dietitian follow-up scheduled regularly demonstrated better CC and insulin corrective factor knowledge when compared to the control group ($p < 0.05$). The continuous education of diabetic patients about nutrition management needs to continue because healthcare providers must also work toward enhancing the educational level of diabetes adults who are under forty or recently diagnosed.

Age Group Distribution: A total of 61.3% of participants belonged to the 18-30 year age group yet only 5.4% fell into the 31-45 year segment and the 46-60 year age range also contained 5.4% participants. The sample distribution suggests younger British adults participating in this study because young people are actively learning about diabetes control or because their disease has started early enough to need immediate medical attention.

Gender Distribution: The surveyed group had an equal gender split as male participants made up 53.3% while female participants constituted 46.7%. The balanced gender distribution opens possibilities to study gender-specific diabetes management approaches together with knowledge and preventive care limits.

Education Level: The majority of participants reached at least high school completion level (44.9%) while university holders comprised 17.8% and people with postgraduate degrees accounted for 0.7%. Educational programs play a critical role in diabetes self-care since they teach about insulin use along with carbohydrate counting so healthcare providers must develop specific educational strategies.

Duration of Diabetes: The research participants reported that 30.1% had diabetes for 1-5 years yet 25.1% had it for 6-10 years and 25.1% had it extending beyond 10 years. People who have lived with diabetes for more than 10 years seem to show better understanding of managing their illness since about one-quarter of participants fall in this category.

Insulin Treatment Type: All respondents indicated that their insulin treatment involved injections whereas insulin pumps and other treatment methods remained absent from their reports. The consistent insulin administration creates a strong starting point to understand adjustments using carbohydrate counts and glycemic control methods.

Knowledge of Carbohydrate Counting: Results showed that 66% of participants knew about carbohydrate counting although only 22% actually implemented its practice. The substantial knowledge-to-action gap demonstrates diabetic patients require enhanced education about self-care so their acquired information produces meaningful practice results.

Insulin Correction Factor Use: Participants demonstrated good understanding of insulin correction factors yet their application to adjust insulin doses showed inconsistency because only 93% perceived themselves knowledgeable about these factors. The results demonstrate a problem with current diabetes education methods since proper correction factor implementation remains insufficient for effectively managing blood sugar levels.

Frequency of Blood Sugar Fluctuations: Many patients from this study indicated that they dealt with regular significant changes in their blood sugar levels when their HbA1c was higher than 8.0%. Better management practices such as improved insulin correction protocols along with dietary changes need to be implemented because blood sugar shows inconsistent levels.

Challenges and Support Needs: The most common challenges revolved around carbohydrate portion control struggles as well as restricted diet resources availability and the inability to follow insulin correction factor requirements. The patients requested better tools that included mobile applications and educational materials along with increased availability of nutritionists and diabetes specialists to help them improve their disease management skills.

Insights & Recommendations: The results suggest several opportunities for development. First of all, the knowledge of carbohydrate counting and insulin correction factors is evidently limited, which implies the opportunity for the development effective educational interventions to enhance the participants' gycaemic control. Second, the steady calls for improved tools and professionals, particularly nutritionists, suggest improving the overall experience of diabetes self-management. Last, the total glycemic count and carbohydrate counting as related to education level help to conclude that educational programs should be specific to age and educational level to be most effective. Similarly, investigation of how male and female diabetics handle their conditions could also generate more effective approaches to treatment. Multiple improvement opportunities emerged from the study results. Patients need better educational programs about carbohydrate counting and insulin correction factors because their current understanding remains insufficient to promote glycemic control. The high demand for better diabetes management resources combined with healthcare expertise of dietitians and educators indicates the need to extend both services.

5.6. Key Findings

1. Low Awareness of Carbohydrate Counting and Insulin Corrective Factors: However, with reference to CC and insulin corrective factors, majority of patients that attended clinics and hospitals had poor knowledge on this techniques.

2. Positive Impact of Education: Education was found to be positively related to better knowledge of CC and insulin correction techniques.

3. Role of Dietitian Follow-Ups: Another important aspect on which constant seen to patients by dietitians was helpful in reinforcing these fundamental diabetes self-care practices.

4. Poor Glycemic Control: Among the patients who did not know about CC and insulin correction, glycemic control was worse which pointed out the need to improve patient knowledge in order to achieve better long-term results.

6. Discussion

The purpose of this research was to evaluate the knowledge regarding CC and insulin corrective factors among T1DM in Tabuk city, Saudi Arabia. The outcomes identified several crucial and far-reaching implication about the awareness and management of T1DM patients found on the specified region concerns that was deemed important for the improvement in diabetes care and education.

Carbohydrate counting is an essential aspect of the diet that help to control the improved blood glucose levels especially to patients with T1DM who are on intensive insulin therapy. But in this study, only 66% of respondents reported they had heard about CC at some point, and only 22% used it. These findings accord with the other research done in KSA, revealing that even with enhanced awareness, areas of practical implementation of CC remain limited [6][13]. The failure to use CC on a regular basis could be associated with low training, lack of diet or general difficulties in implementing CC in everyday practice.

This means the results showed that levels of education were positively correlated to levels of awareness and use of CC. And this indicates that patients who have a better educational standard will embrace more complex diabetes management strategies like CC in view of their higher health literacy requirements. This is similar to earlier work that pointed to the significance of education for diabetic medicine management [6][7]. Further, follow up with dietitians was found to be positively linked with awareness demonstrating the value of professional contact in diabetes management.

6.1. Insulin – Corrective Factors and Their Importance

The study findings showed that 93% of participants were familiar with insulin corrective factors although many missed the mark when it came to making appropriate insulin dosage adjustments. The process of intensified insulin treatment calls for accurate insulin dosage modifications which directly correspond with blood glucose patterns together with carbohydrate consumption. The relationship between understanding insulin corrective factors matched carbohydrate counting data because both results correlated to participant levels of education and their frequency of dietitian consultations. Research output reveals the dependency of successful glycemic control on lessons which distinctly teach insulin correction skills. Medical staff demonstrate good knowledge about insulin correction factors yet their usage remains restricted which reinforces the need for hands-on training in diabetes education to achieve better outcomes for patients. The outcomes of this study corroborate implications suggested by prior works that underscores extensive training on insulin dose adjustment for effective diabetes management [7][8].

7. Conclusion

The findings have realized that awareness and use of carbohydrate counting and insulin corrective factors are lacking severely among the Type 1 diabetes patients of Tabuk, KSA. General knowledge of these techniques should be increased by targeted educational programs, preferable addressed to population with lower education level or with limited access to dietitian services which could play significant role in glycemic control and other diabetes complications in the region.

These findings have exposed the existence of knowledge and management gaps on CC and insulin corrective factors among T1DM patients in the Tabuk region of Saudi Arabia. Even though the use of these strategies is so crucial in attaining the best control of glycemia, a small percentage of participants reported frequent use of CC and dose of insulin adjustment in accordance with corrective factors. The knowledge and practice of the above glycemic control techniques were significantly improved by higher educational levels, regular follow up visits with dietitians, and short duration of diabetes.

The findings underscore the rationale for more specific educational efforts to increase CC knowledge and application of insulin slope corrections. Such actions may enhance patients' self-regarding to the state of T1DM, enhance the control of their glycemic level and minimize long-term effects of the disease. Moreover, supporting patients with diabetic diets and providing them with information on diabetes itself or making them attend professional dietitian support should be a priority for officials among patients with low education level or recently diagnosed ones.

Therefore, there is a need to raise awareness and enhance adherence to carbohydrate counting and insulin correction among T1DM patients in Tabuk to improve their diabetes self-management and quality of life. This, coupled with education and support activities, is what is require to ensure that the knowledge gaps are closed and improved health status for people with T1DM in the region is achieved.

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