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Review article

Physical activity can improve diabetes patients' glucose control; A systematic review and meta-analysis

Mulu Shiferaw Asfaw [a], Woldeteklehaymanot Kassahun Dagne [b,*]

[a] Biomedical Unit, School of Medicine, College of Health Sciences, Woldia University, Woldia, Ethiopia
[b] Department of Medical Laboratory Sciences, College of Health Sciences, Woldia University, Woldia, Ethiopia

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ABSTRACT

Background: Glycemic control is vital to patient care, and it is still the most important treatment goal for reducing organ damage and other complications associated with diabetes. Physical activity is one of the factors that affects glycemic management. Therefore, the aim of this systematic review and meta-analysis was to find, evaluate, and synthesize the best available information on the link between physical exercise and glycemic control in Ethiopian diabetes patients.

Methods: Pubmed, Science Direct, Google Scholar and African Journals Online were the databases searched. In addition, gray literature were explored. All papers chosen for inclusion in the review underwent a thorough critical appraisal utilizing the Joanna Briggs Institute's standardized critical appraisal instruments (JBI critical appraisal checklist-2017). For statistical analysis and descriptive synthesis, quantitative articles were combined. The Odds ratio and their 95% confidence intervals were generated. Papers that were of excellent quality but lacked the main outcome (physical activity) for meta-analysis were subjected to descriptive synthesis.

Results: The finding of this meta-analysis showed diabetes patients who were physically active had controlled their blood glucose levels by 2.4 times compared to their counter (Odds ratio = 2.40, 95% Confidence Interval = 1.57,3.69). The duration of disease was found to be the most commonly reported predictor for poor glycemic control followed by dietary habits, patients' sex and age.

Conclusion: Physical activity, which is a simple and inexpensive therapy for diabetes patients, can help them control their blood glucose levels. Patients with diabetes who have had it for a long time should be aware of the need of regular physical activity in maintaining blood glucose control.

1. Introduction

Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia due to a problem of insulin secretion, action, or both [1]. Diabetes prevalence has climbed from 108 million in 1980 to 422 million in 2014, with 640 million expected by 2040. Prevalence has risen quicker in low- and middle-income nations than in high-income countries [2]. Diabetes will be 5.1 percent in Ethiopia in 2035, up from 4.4 percent in 2013 [3].

The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of different organs [1]. By generating mitochondrial superoxide, hyperglycemia damages retinal capillary endothelial cells, renal glomerulus mesangial cells, peripheral nerve neurons, and Schwann cells. These cells are particularly prone to damage because they are unable to regulate glucose absorption during hyperglycemia [4]. In diabetes patients, persistent hyperglycemia is the major cause of blindness, end-stage renal failure, and stroke [5].

Glycemic control is critical to patient care, and it remains the primary therapeutic objective for preventing organ damage and other problems associated with diabetes [6]. Glycated hemoglobin (A1C) values > 7.0 percent (poor glycemic control) are associated with a considerably elevated risk of both microvascular and cardiovascular (CV) problems, regardless of the underlying treatment [7].

Now a days, clinical care and medicine tailored to the patient are promoted rather than the usual wholistic approach. This medical practice is called precision medicine which is a medical model that separates people into different groups with medical decisions, practices, interventions and/or products being tailored to the individual patient based on their predicted response or risk of disease [8, 9].

* Corresponding author.
E-mail address: teklu1142@gmail.com (W.K. Dagne).

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Diabetes is one of the clinical conditions which need a personalized treatment approach tailored to each patient as they may be different in terms of lifestyle, race, nutritional habits and others [10]. From these variabilities, physical activity is one. Therefore, a treatment approach targeting monitoring of physical activity and exercise of diabetes patients has been indicated as one of the inexpensive treatments with great improvements [11, 12, 13].

Physical activity is one of the factors that affect glycemic management. Exercise-induced glycemic control is mostly explained by an increase in whole-body insulin sensitivity. The long-term advantages of frequent exercise on glycemic control appear to be related to the cumulative effect of transitory gains in insulin sensitivity and glycemic control after each bout of exercise, rather than structural changes in insulin sensitivity [14]. Nonetheless, it's worth mentioning that the benefit of exercise training on insulin sensitivity decreases 5–10 days after you stop exercising [15, 16]. When moderate-intensity exercise is undertaken regularly, however, the ability to sustain increased insulin sensitivity can be extended. As a result, repeated exercise every 48–60 h may help regulate blood glucose levels in the long run [17]. This is why diabetes patients must exercise regularly to obtain a long-term favorable effect on blood glucose homeostasis. Furthermore, this idea highlights the relevance of each individual exercise session's gluco-regulatory qualities in achieving good long-term glycemic management [18].

We start this study believing that physical activity can control the serum glucose of Ethiopian diabetes patients positively. Thus, the main purpose of this study was to find, evaluate, and synthesize the best available information on the link between physical exercise and glycemic control in Ethiopian diabetes patients. Meanwhile, we set out to assess, identify, and describe the most common predictors of glycemic control problems in Ethiopian diabetes patients.

2. Method

2.1. Search strategy

The findings of this review article were reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-2020) guideline [19]. Online public databases such as Google Scholar, African Journals Online, PubMed, and Science Direct were used to find related published studies on glycemic control among diabetes patients in Ethiopia. Google was used to look for gray literature.

The search terms were chosen in accordance with the Medical Subject Heading (MeSH) utilizing a keyword arrangement to find related research publications. The following was the search strategy used to find relevant articles: (((glycemic control) OR (glycated hemoglobin) OR (hemoglobin A1C)) AND (Diabetes patient)) AND (Ethiopia). To organize references and delete duplicates, the reference management software EndNote 20 was used.

2.2. Selection criteria

This study comprised studies that looked at physical activity habits as a determinant in glucose control. Studies that used linear regression analysis to look at the degree of physical activity's link with glycemic control were included. Pregnant women, comorbid patients, children, and prospective studies were also excluded from the investigation.

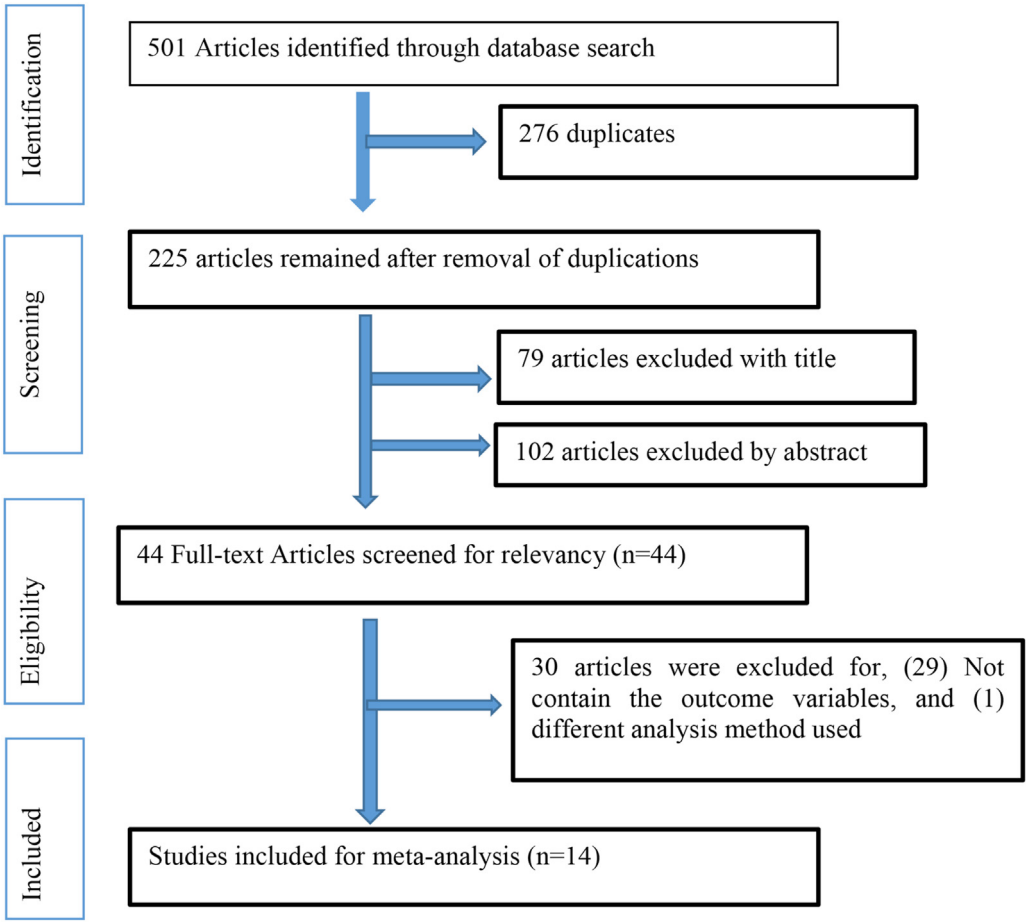

Figure 1. PRISMA flow diagram showing search results for the inclusion of studies reporting the assessment of physical activity effect on diabetes patients' glucose control.

2.3. Data extraction and quality assessment

All papers chosen for inclusion in the review underwent a thorough critical appraisal utilizing the Joanna Briggs Institute's standardized critical appraisal instruments (JBI critical appraisal checklist-2017) [20]. Study selection assessment and extraction were done twice to reduce reviewer mistakes.

According to the qualifying criteria, all authors independently read the titles and abstracts of the included publications, as well as the entire text of the selected articles. Disagreements among authors were also resolved by debate and consensus. Papers that were of excellent quality but lacked an adequate data set for meta-analysis (the outcome variable physical activity) were subjected to descriptive synthesis.

Data extraction was done in collaboration by both authors. We worked out our differences through verification and more conversation. The following information was gathered for analysis: author, publication year, study area, frequency of good glycemic control among physically active and inactive patients, and frequency of physically active and inactive diabetes patients.

2.4. Statistical analysis and synthesis

Primary studies that met the criteria were retrieved, entered into Microsoft Excel, and then analyzed with Review Manager 5. In the meta-analysis, we utilized the random effect model and the Mantel-Haenszel model to generate odds ratios and their 95 percent confidence intervals. The inverse of variance was used to assess the degree of heterogeneity amongst the included studies (I^2). The funnel plot was used to objectively assess publication bias across studies.

3. Result

The literature search returned 501 relevant publications, 276 of which were duplicates, leaving 225 to be reviewed. After comparing titles and abstracts to the review objectives and inclusion criteria, 181 papers were excluded. The remaining 44 studies' whole texts were gathered for a comprehensive evaluation, and 30 of them were discarded. The remaining 14 were included in the current systematic review and meta-analysis (Figure 1).

3.1. Characteristics of studies included

From the total of 501 studies underwent fulltext review and critical appraisal, fourteen [21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34] were selected for meta-analysis while 19 papers including the former and additional five studies [35, 36, 37, 38, 39] were used for descriptive review. Studies included in the meta-analysis were those papers which studied (or described) the association of physical activity and glycemic control among adult Ethiopian diabetes patients. On the other hand, studies those assessed associated factors (or predictors) with glycemic control improvement among adult Ethiopian diabetes patients but didn't mention physical activity were added to the descriptive review. The descriptive review described the most frequently reported predictors of glycemic control among adult Ethiopian diabetes patients (Table 1).

3.2. Association of glycemic control with physical exercise

A total of 4178 diabetes patients were included in this study, out of them 1810 (43.3%) had good glycemic control. About 2024 (48.4%) were physically active, out of them 1053 (52.02%) had good glycemic control. Studies done in Oromia region accounted for nearly half of the studies (42.8%).

The finding of the Meta-analysis showed diabetes patients who were physically active were 2.40 times more likely to have controlled blood glucose compared to physically inactive diabetes patients (Odds ratio = 2.40, 95% Confidence Interval = 1.57,3.69) heterogeneity test: $i^2 = 88\%$, df = 13 ($P < 0.0001$) (Figure 2).

Table 1. Characteristics of studies included for systematic review and meta-analysis.

First Author, Publication year	Region	Studied population	The most commonly reported Predictors of glycemic control	Reference
Daba A et al., 2022	Oromia	350	Physical activity, sex, age, alcohol consumption	[21]
Mohamed AS et al., 2021	Amhara	129	Physical activity, duration of diseases, dietary habit, educational status, occupation, body mass index (BMI)	[22]
Bizuayehu A et al., 2020	SNNPs	220	Physical activity	[23]
Berhane F., 2017	Tigray	200	Physical activity, duration of disease, dietary habit, educational status	[24]
Genenus F et al., 2019	Oromia	228	Physical activity, duration of diseases, dietary habit, sex, age, alcohol consumption, educational status	[25]
Adane T. et al., 2019	SNNP	168	Physical activity, duration of disease, dietary habit, residency	[26]
Yitagesu M et al., 2019	Oromia	410	Physical activity, duration of diseases, educational status, residency	[27]
Tekleowoini et al., 2020	Tigray	260	Physical activity	[28]
Shambel N et al., 2021	Dire-Dawa	394	Physical activity, sex	[29]
Adugna O et al., 2021	Oromia	398	Physical activity, duration of diseases, sex, BMI	[30]
Tadesse S et al., 2020	Oromia	330	Physical activity, duration of diseases, dietary habit, sex, age, alcohol drinking, chat chewing, educational status, occupational status, residency, BMI, type of DM	[31]
Tariku S et al., 2018	Addis Ababa	361	Physical activity, Duration of diseases, dietary habit, sex, age	[32]
Tewodros Y et al., 2021	Oromia	245	Physical activity, Sex, chat chewing, educational status, BMI	[33]
Beakal Z et al., 2019	Oromia	392	Physical activity, Occupational status	[34]
Additional studies included for descriptive review				
Abera RG et al., 2022	Addis Ababa	325	Duration of disease, dietary habit, age	[35]
Alemu T et al., 2021	Addis Ababa	245	Sex	[36]
Cheneke W et al., 2016	Oromia	148	Duration of diseases, sex, age, educational status, BMI	[37]
Feleke BE et al., 2021	Amhara	2554	Duration of diseases, sex, age, BMI, type of DM	[38]
Mariye T et al., 2019	Tigray	87	Duration of disease, dietary habit	[39]

3.3. Description of the studies

The length of disease was found to be the most commonly reported predictor of poor glycemic control (n = 12 studies) [22, 25, 26, 27, 30, 31, 32, 35, 37, 38, 39, 40], whereas dietary habits were the second most commonly reported independent predictor of poorly controlled glucose levels (n = 8) [22,25,26,31,32,35,39,40]. Patients' sex (n = 10 studies) [21, 25, 29, 30, 31, 32, 33, 36, 37, 38] and age (n = 7 studies) [21, 25, 31, 32, 35, 37, 38] were found to be predictive of glycemic control among biologic variables. Three studies reported that alcohol use was also associated with glycemic control [21, 25, 31], while two articles stated khat chewing [31, 33] as a predictor of glycemic control. The most commonly reported socio-demographic variable is the educational status (n = 7 studies) [22, 25, 27, 31, 33, 37, 40], whereas residency [26, 27, 31] and employment status [22, 34] were reported by three and two papers, respectively, as predicting glycemic control. Body mass index was reported by six authors [22, 30, 31, 33, 37, 38]. Only two studies reported type of diabetes as a predictor of glycemic control [31, 38].

4. Discussion

The complications of diabetes are the leading causes of mortality and morbidity globally [41]. To tackle this health problem, the provision of targeted medical services is important. This need initiated the model precision medicine which has a philosophy of tailored approach to each diabetes patients [8, 9, 42].

Exercise and physical activity have been linked to improved longevity, decreased cardiovascular morbidity and mortality, as well as a decreased chance of developing complications of diabetes, such as retinopathy, neuropathy, and nephropathy in people with type 1 diabetes. Exercise is linked to gains in physical fitness, a reduction in various cardiovascular risk factors, and reductions in mean blood glucose levels for those with type 2 diabetes and those at risk of getting it (commonly referred to as prediabetes) (as reflected by lower hemoglobin A1c) [43,44].

According to the American Diabetes Association's advice moderate-intensity physical activity is thought to improve glucose control and so minimize diabetes' acute and chronic consequences [45]. As a result, the goal of this study was to find, evaluate, and synthesize the best available information on the link between physical activity and glycemic control in Ethiopian diabetes patients.

From the meta-analysis we conducted, physical activity can enhance glycemic control by 2.40 times compared to physically inactive diabetes patients (OR = 2.40, CI = 1.57–3.69). Which was supported by studies reported from Ghana [46], Nigeria [47, 48], Korea [49], Germany and Austria [50] and Brazil [51].

Lowering blood sugar levels can be accomplished by boosting insulin activity through aerobic exercise and increased muscle mass through resistance training. When aerobic and resistance exercise are combined, glycemic management is thought to be enhanced. Glycemic control is connected to decrease cardiovascular risk in both Type 1 and Type 2 diabetes, and long-term therapy and follow-up studies have revealed that early intense control is linked to lower cardiovascular risk [45, 52, 53].

Furthermore, genome-wide association studies (GWASs) have found many genetic variants connected to susceptibility to complex disorders, and the interactions between genetic information and nutrition, referred to as nutrigenomics, have recently attracted considerable attention. Genetic diversity affects how people react to food changes [54]. Similarly, food and nutrition influence gene expression, epigenetic features, and gut flora to personalize the response to interventions. This motivates us to pursue new avenues for bettering our understanding of pathophysiological mechanisms and developing precision dietary solutions for diabetes prevention and control [55].

This study demonstrates that diabetes patients in Ethiopia should emphasize diet in addition to physical exercise, as dietary alterations were one of the controllable components associated to glycemic control and were deemed a predictor by multiple authors. Maintaining plasma glucose levels requires a well-balanced diet, as described by the World Health Organization [56]. Different diets with different food compositions cause changes in metabolites and the gut flora, which are important for the whole body's glucose metabolism [57]. Different amino acid-containing diets, for example, might cause changes in plasma branched-chain amino acid (BCAA) concentrations, which are associated with Type 2 Diabetes risk [58].

For ages, people in the Arabian Peninsula and the Horn of Africa, particularly Ethiopia, have practiced khat chewing [59, 60]. Even though there were a few contradicting observations while exploring the effects of khat on glucose metabolism and insulin secretion in the literature, it has been demonstrated to increase serum glucose level-hyperglycemia [61, 62, 63, 64, 65, 66]. Chewing khat has a considerable unfavorable impact on glucose management in diabetes in Ethiopia, according to the current study.

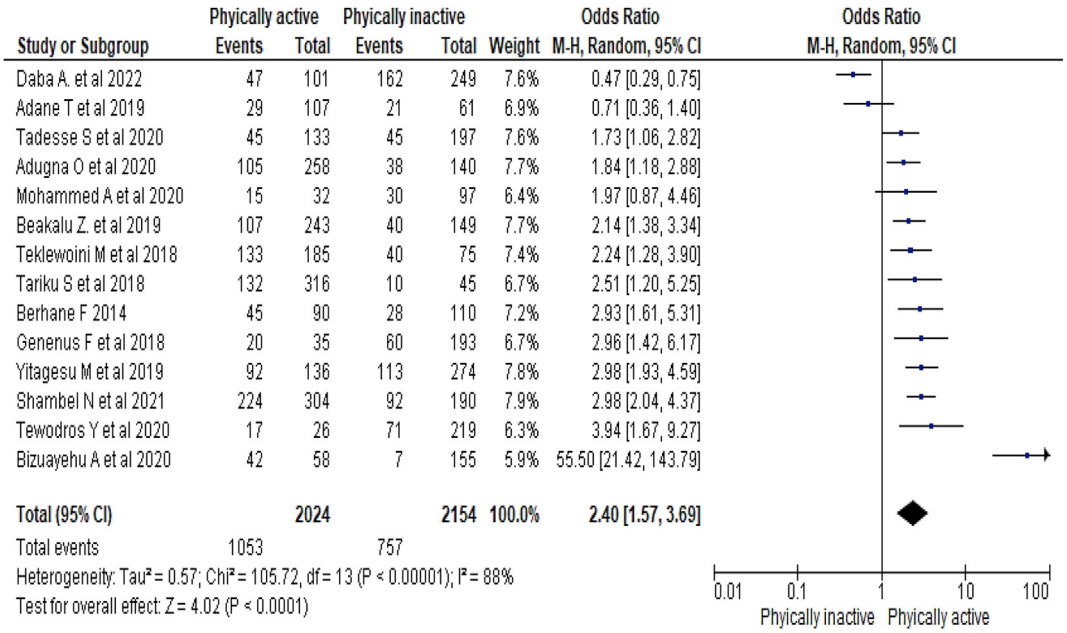

Figure 2. Forest plot physical activity versus glycemic control of diabetes patient in Ethiopia.

Alcohol use was noted by various writers as another modifiable factor that influences glycemic control. Both diabetes and non-diabetes are affected by alcohol's impact on glucose metabolism. Alcohol can produce hypoglycemia when drunk without meals because it slows both gluconeogenesis and glycogenolysis. This is especially true when glycogen levels are low and when paired with sulphonylureas [67]. In the diabetes population, alcohol consumption is inversely associated with glycemic control [68].

5. Conclusion

Physical activity can help diabetes control their blood glucose levels. The role of physical activity in blood glucose control should be stressed to health care providers and their patients. According to many authors, blood glucose monitoring is an important part of glycemic control in patients who have had a condition for a long time. Patients can reduce the number of unnecessary problems connected with diabetes by restricting alcohol and khat consumption.

Declarations

Author contribution statement

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Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

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