Abstract

The Arabic-speaking region suffers from insufficient levels of physical activity (PA). Assessing the effectiveness of PA interventions presents a scientifically evaluated method to reduce and prevent the current high burden of non-communicable diseases affecting this region. This review examined implemented PA interventions and corresponding measured health outcomes in this region. The review was limited to studies prior to January 2020 using nine electronic academic databases. Only intervention-focused articles incorporating PA as the primary intervention or as a component of a multi-behavioral intervention were included. Thirty-nine PA intervention studies were identified. Published PA interventions were implemented among 50% of the countries in the region. Seventy percent of the studies were conducted in the Gulf region, and 25% in North Africa. A third of the studies were designed for children and adolescents. Accordingly, 40% of interventions were for patients living with comorbidities. Seventy percent of the studies included PA as part of a multidisciplinary intervention. Most studies included Body Mass Index as an outcome parameter. Significant improvement ($p<0.05$) in measured health outcomes was seen in 97% of studies. Thorough analysis includes social and culturally congruent aspects of the PA interventions and discussion of resultant health outcomes. This information furthers understanding of effective PA interventions that can be adapted to target sedentary lifestyle behaviors in this region.

Keywords

Physical activity, Middle East, North Africa, Obesity

1. Introduction

Extensive evidence demonstrates an international increase in non-communicable diseases (NCDs), due in part to insufficient levels of physical activity (PA). [1] According to the World Health Organization (WHO), physical inactivity is the fourth leading cause of global mortality, which accounts for an estimated 13.4 million disability adjusted life years (DALYs) and is linked to

chronic diseases, such as cardiovascular disease, stroke, and diabetes. [2] The authors subscribe to the following definition of insufficient PA -/span> not attaining the recommended minimum requirement of 30 minutes of moderate exercise for five days per week, or 20 minutes of vigorous exercise for three days per week. Of concern, current literature reports that 60% of the world's population does not achieve the minimum PA recommendations. [3] Changes in labor and transportation in middle and high-income countries have increased dependence on passive modes of transportation (e.g. motor-vehicles, public transit) and decreased dependence on active modes of transportation (e.g. walking or bicycling). [4,5] Increasingly, PA tools are significantly associated with reduced risks of premature mortality and development and/or progression of chronic medical conditions, including cardiovascular diseases, stroke, hypertension, and type 2 diabetes. [6,7] PA is, therefore, globally recommended as a method for improving population health and preventing the development of chronic non-communicable diseases. [4] Thus, in 2013, the WHO established several voluntary global targets aimed at reducing physical inactivity by 10% [4] by recommending that individuals perform 150 minutes of moderate-to-vigorous PA per week. [4]

In the Arabic-speaking region, less PA is performed on average compared to other regions of the world, such as the Gulf Cooperation Council (GCC), consisting of the high-income countries Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates (UAE). [8] The low prevalence of PA has contributed to an epidemic of associated heart disease morbidities in the Arabic-speaking region. [4] In middle- and high-income Arabic-speaking countries, the adoption of a westernized diet and physical inactivity are associated with ischemic heart diseases – a leading cause of death within these countries. [4,9] Sedentary lifestyles have become more prominent in Arabic-speaking countries due to increases in modern transportation and prolonged duration of time watching television, browsing the internet, or playing video games. Consequently, physical inactivity appears to be an independent risk factor for developing NCDs. [2,10] According to the WHO,

insufficient levels of PA among Arab adults ranged from 33-86% in seven Arabic-speaking countries (Egypt, Iraq, Jordan, Kuwait, Saudi Arabia, Sudan and Syria). [11] Additionally, Musaiger et al. [12] reported that the majority of Arab adolescents in these countries did not perform the recommended levels of PA per day. Studies report that women have lower PA than men in Arabic-speaking countries due to sociodemographic factors such as age, marital status, job positions with sedentary work nature, and necessity to work multiple shifts. [13]

Physical inactivity is one of the most influential contributing factors of obesity. [14,15] In Arabic-speaking countries, NCDs associated with obesity are becoming increasingly prevalent. [4,5,8,16] The literature presents numerous barriers to performing PA in Arabic-speaking countries, including cultural norms such as gender roles that may prevent women from accessing PA due to strong patriarchal constructs in some Arab societies. Correspondingly, Balhareth et al. [13] demonstrated that overweight or obese individuals expressed personal barriers (e.g. lack of interests, skills, and motivation) and social barriers (e.g. embarrassment/fear of comparison to colleagues when exercising outdoors) that discouraged them from performing PA. Additional barriers to PA reported in the literature include prohibitive costs for constructing and/or maintaining public recreational centers; however, these barriers were not as salient in the literature compared to the other barriers expressed. [17]

Given the importance of improving health outcomes in the Arabic-speaking region, PA interventions present a scientifically evaluated method to prevent and/or reduce the burden of NCDs. Researching multidisciplinary PA interventions that account for socio-cognitive, cultural, and environmental barriers as well as facilitating factors may provide guidance for regional, national, and international policies and programs. Blair [18] accurately described the 'Arab World' as a heterogeneous group composed of 22 member countries of the League of Arab States that have different health profiles, public health policies, health care systems, and distinct research challenges. Hence, effective implementation requires adapting

PA interventions to reflect cultural and religious differences among populations in these countries. Therefore, the purpose of this review is to understand the effectiveness of PA interventions implemented in the Arabic-speaking region by examining the interventions' corresponding measured health outcomes. Further, we provide an in-depth analysis and discussion of the measured health outcomes, and we provide recommendations for enhancing the robustness of future interventions that may lead to sustainable behavior change among individuals in Arabic-speaking countries. Such information is crucial for recommending socially and culturally relevant health promotion plans that target sedentary lifestyle behaviors among individuals in Arabic-speaking countries.

2. Methods

A literature review was conducted prior to January 2020. The following search terms were used in combination : "Physical Activity"; "Exercise"; "Intervention"; "Program" AND "Algeria"; "Egypt"; "Bahrain"; "Comoros"; "Djibouti"; "Iraq"; "Jordan"; "Saudi Arabia"; "Kuwait"; "Lebanon"; "Libya"; "Mauritania"; "Morocco"; "Oman"; "Palestinian Territories"; "Qatar"; "Yemen"; "Somalia"; "Sudan"; "Syria"; "Tunisia"; "the United Arab Emirates". Arabic-speaking countries were defined as the 22-member countries of the League of Arab States. [19] Studies published prior to January 2020 were included in the review to best obtain relevant published data. Nine academic electronic databases were used for the literature search: Scopus; PubMed; SpringerLink; Wiley Online; ProQuest; ArticleFirst; EBSCOhost; Taylor & Francis; and ScienceDirect. These databases were selected due to their medical and biomedical scope. All retrieved articles were screened for relevance to the topic. In addition, reference lists from retrieved articles were also hand reviewed to identify additional relevant publications (see Figure 1).

2.1 Inclusion/Exclusion Criteria

The literature search was limited to articles published in Arabic, French, or English languages. Only intervention-focused articles that incorporated PA as either

a primary intervention or as a component of a multi-behavioral intervention were included. Protocol studies were also included. Studies that examined Arabic-speaking populations or migrants of Arab origin residing in non-Arabic-speaking countries were excluded in the search. Qualitative studies, brief communications, grey literature, non-peer reviewed publications, and dissertations were also excluded.

3. Results

PA intervention studies (see Table 1) were conducted in 50% of the Arabic-speaking countries (*n*=11 countries). Most studies (70%) were conducted in the Gulf region, notably in Saudi Arabia and UAE, while 25% were conducted in North African countries. Fifteen percent of the studies were conducted in the Middle East region. In terms of target population, one-third of the studies targeted children and adolescents between the ages of 5-19 years of age. Of these studies, five focused on weight reduction among adolescents living with may be define as overweight and obesity. Most of the PA interventions included both males and females. Forty percent of the studies were interventions designed for individuals with comorbidities such as obesity, pre-diabetes, diabetes mellitus, and a high blood lipid profile.

Intervention duration was highly variable and ranged from 8 weeks to 3 years. However, most of the studies reported a 6-month intervention. Further, in a quarter of the studies, PA was part of a multidisciplinary intervention that included educational programming; albeit, specific recommendations on exercises or intensity was not communicated. Moderate-vigorous and low exercise intensity were assigned to participants in 38% and 21% of studies, respectively.

General health indicators were measured in almost all the studies with focused inclusion on BMI. However, there was a noticeable variation in the studied parameters giving the variability of age, design, and existence of comorbidities. Notably, only one study included a quality of life measure. Apart from one study, all studies revealed significant improvement ($p<0.05$) in measured health outcomes. Additionally, except for one study, all studies that included an

educational program reported significant health improvements ($p<0.05$) among participants.

4. Discussion

The current review aimed to better understand the effectiveness of PA interventions implemented among various populations in the Arabic-speaking region by examining the interventions' corresponding measured health outcomes. Results of this review highlight several aspects to consider for future PA interventions. Therefore, recommendations for enhancing robustness of future interventions that may lead to sustainable behavior change in Arabic-speaking countries are communicated below. First, the number of published PA intervention studies conducted in Arabic-speaking regions that met inclusion criteria (*n*=39) reflects increasing interest in addressing negative health outcomes associated with a sedentary lifestyle in these countries. Public health researchers have identified the need to reduce sedentary lifestyles and increase PA. Our review found that published PA interventions to address sedentary lifestyles amplified around 2010 in the Arabic-speaking region. [20] Published PA intervention studies steadily increased with six published studies in 2016, [21-26] seven in 2017, [27-33] and six in 2018. [34-38]

Distinct from efforts on physical inactivity published by Sharara et al. [2], our analysis focused solely on peer-reviewed studies where PA was the primary intervention or was a component of a multi-behavioral intervention. Additionally, our study is unique compared to the noted efforts of Benjamin [39] by assessing aspects other than barriers and facilitators that are important to the success of interventions, such as social and cultural factors. The effort by Kahan [4] supports our work by highlighting the extent of physical inactivity among Arabic-speaking countries and the subsequent need for PA intervention efforts. Collectively, Kahan [4] and our review provides guidance for designing and conducting future PA interventions, with the goal of achieving a 10% reduction of physical inactivity globally by 2025 as established by the WHO. The current review highlights areas to

consider in implementing PA interventions as we build on prior work.

Among all studies in the conducted literature search, there is consensus regarding the importance of PA in preventing negative health outcomes; evidently, combining education and PA is important to achieve the best health outcomes. [22,25-27,29,30,32,36,40-49] Our findings also suggest a need for adapting interventions for varying cultures and genders to promote increased PA. Efforts in the United States to achieve health equity include the Healthy People 2020 goal of "Use health communication strategies and health information technology to improve population health outcomes and health care quality, and to achieve health equity"; [50] efforts toward this goal includes clear communication of health messages, accounting for literacy aptitude and cultural-linguistic salience through transcreation of evidence based interventions. [51,52] Thus, we found these studies in the current literature review represent strong examples to model in the creation of PA interventions that include an educational component.

Despite researchers reporting low attrition and high acceptability (full of engagement) in their PA intervention studies , socio-cultural challenges were encountered during implementation of several interventions conducted in countries such as Jordan,[53] Kuwait,[54] Lebanon, [55] Oman, [28,56] and the Occupied Palestinian Territories. [22] Adedeji et al. [44] reported that women had limited participation in regular PA in the intervention due to socio-cultural constraints. However, within the reviewed literature, culture was also considered critical to intervention success. As such, Mohamed et al. [43] and Stanley et al. [32] designed culturally sensitive interventions that leveraged the Arabic language and the use of local, cultural examples, such as food habits and health beliefs that reflected the populations of Qatar and UAE, respectively. Furthermore Al-Haifi et al. [54] found that family support was a prominent motivating factor for adolescent participation in the intervention. Sahli et al. [25] emphasize the importance of considering social, economic, and cultural contexts when establishing policies and programs that promote PA.

Similar to findings communicated in studies assessing physical inactivity,[2] we found a need for standard measures and standard reporting, as many of the studies in the literature review used varying measures and standards for reporting. Hence, consistency in measuring health outcomes are recommended, as standard measures would allow for comparison of the effectiveness of PA interventions. This, in turn, would allow for stronger guidance on evidence-based interventions for future efforts in improving health outcomes. Future PA interventions should also implement quality of life (QOL) measures; this would help demonstrate whether PA interventions and PA education can improve QOL among individuals in the Arab-speaking region. This recommendation could potentially further empirical support that PA not only assists in the reduction of negative health outcomes but increases efficacy, mental health, and emotional health. Our literature review found that PA interventions have not been implemented in all Arabic-speaking countries. Hence, we strongly voice a regional call-to-action directed at Government entities, Ministries of Health, Academic Institutions, and research centers in these respective countries to increase their focus on PA research that uses evidence-based, empirically grounded programming in an effort to counter rising obesity and comorbidity rates. These efforts would provide more evidence-based results of the suitability of using PA, coupled with nutrition and diet education, to reduce obesity rates among populations in Arabic-speaking countries.

5. Conclusions

Our review assessed the published literature on PA interventions among Arabic-speaking countries. Our in-depth analysis included social and culturally congruent aspects, and a discussion of resultant health outcomes. Further, we provide recommendations for enhancing the robustness of future interventions that may lead to sustainable behavior change in Arabic-speaking countries. This information is crucial for recommending adapted health promotion plans that target sedentary lifestyle behaviors among those living in Arabic-speaking countries.

Declaration of interest statement

The authors declare no conflict of interest.

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FIGURE 1 Flow Diagram of Literature Search Process

(please see Figure 1 File)

TABLE 1 Physical activity interventions in Arabic-speaking countries (*n*=39)

(please see Table 1 File)

TABLE 1 Physical activity interventions in Arabic-speaking countries (*n*=39)

Authors (Year)	Country	Target Population	Type of Study	Sample Size	Type of Intervention	Details of PA Intervention	Duration of Intervention	Measured Parameters	Main Results	Main Recommendations
Al Saweer et al., 2015	Bahrain	Adolescents males and females (5-19 y.)	24-week teen-obesity intervention program	N=13	Interventional multidisciplinary program	cardio exercises 60 minutes, 3 times/week + exercises at home + ≥1 hour being active every day	6 months	Body weight BMI Blood pressure Total cholesterol HDL LDL TG HBA1C	Decrease in BMI by -1.4 kg/m^2 from 44.3 kg/m^2 to 42.9 kg/m^2 (*N.B.: Follow up was done for weight only*)	The need to continue prevention efforts in order to make implementation sustainable to help preventing obesity among adolescents.
Al Saweer et al.. 2017	Bahrain	Adults males and females (mean age: 46.3 y.)	Prospective Cohort Study	N=97	Interventional multidisciplinary program as a Work Health Initiative	150 minutes of moderate activity week	6 months	Serum lipids FBS serum HB Thyroid tests, Gender and age-specific periodic examination, HADS	Reduction of obesity. Increase of regular exercise was increased. Decrease in average blood pressure. Significant reduction of stress Reduction in sick leave vs. previous year.	Combining health education and physical activity are effective in the reduction multiple risk factors and disease burdens among workers.
El Ansari et al., 2010	Egypt	Adolescents males and females (mean age for the intervention group: 15.7 y.; mean age for the control group: 15.4 y.	Quantitative study	N=160	Physical activity intervention program	60-minutes moderate-intensity PA physical activity, 3 sessions /week sessions each week Target heart rate (maximum 60–80%)	3 months	Weight BMI Body fat (%) T-chol SBP DBP HR	Decrease in all studied parameters after intervention. Significant difference in all studied parameters among control and intervention group except % of body fat in females. ($p<0.05$)	More attention to physical activity programs in Egyptian school is needed with a special focus on how to motivate pupils to join them.
Hassan et al., 2011	Egypt	Female adolescents (15 -16 y.)	Longitudinal survey + Interventional program	N= 38	Nutritional intervention (Specific dietary program + nutritional education + exercise)	Moderate Physical activity 60 min daily or at least 5 times /week,	6 months	BMI WC WHR Body fat (Fat %) FM FFM Total body water BMR	Significant reduction in waist circumference ($p < 0.01$), FM ($p < 0.01$), fat% ($p < 0.01$), body weight ($p < 0.01$, hip circumference ($p < 0.01$ Significant increase in total body water ($p <$	Combining diet restriction and exercise should be considered for intervention programs.

									0.01) and BMR ($p < 0.01$)	
Metwally et al., 2019	Egypt	Type 2 Diabetic patients (mean age: 52.6 y.)	Cohort study	N=205	Interventional lifestyle health education program	No specific Physical intervention program is designed.	11 educational sessions (no period of time is indicated)	Nutritional behaviours, Physical activity proper medication use level of blood glucose monitoring Anthro-pometric measures.	Significant improvement in the mean scores of behaviours after education session ($p < 0.001$). Significant reduction in the barriers facing patients to diabetes self-management including physical activity barriers ($p < 0.001$) and blood glucose monitoring ($p < 0.001$). Significant and positive correlation obtained between amelioration of medication compliance ($P = 0.027$), blood glucose monitoring ($P = 0.045$), and glycated haemoglobin in participants.	Integrating health education of diabetes management should be recommended at all levels of health care in Egypt, considering Standards of Practice (SOP) of diabetes. .
Bustanji and Majali, 2013	Jordan	Adult women (41 - 69 y.)	True experimental pretest/ posttest study	N=165	Healthy diet + physical activity	30 min of moderate physical activity/day	12 weeks	BMI Risk Perception of risk to CHD Body weight BP Blood glucose level	A decrease of actual risk for heart disease after the intervention ($p<0.001$)	A heart disease education programs at national level is needed and recommended for women. Emphasis should be on adopting healthy lifestyle behaviors.
Alsaleh et al., 2012	Jordan	outpatients with CHD (18-70 y.)	Two-group randomized controlled trial	N=151	Multi-component behavioural intervention	30–60 min of moderate intensity on most or all days of the week.	6 months	PA (Frequency, Duration, intensity) Self-efficacy for exercise and health-related quality of life. SBP DBP Weight Weight perceptions of the intervention (emotional, social, physical, self-efficacy)	This was a study protocol. Results are published by Alsaleh et al., 2016	

Alsaleh et al., 2016	Jordan	Adults outpatients with CHD (18 -70 y.)	Parallel randomized controlled trial	N=156	Multi-component behavioural intervention	30–60 min of moderate intensity on most or all days of the week.	6 months	PA (Frequency, Duration, intensity) Self-efficacy for exercise and health-related quality of life. SBP DBP Weight Weight perceptions of the intervention (emotional, social, physical, self-efficacy)	Significant increase of frequency, duration and intensity of PA and walking (P< 0.05) Significant increase in METs. (P< 0.05) Significant decrease in BP, BMI (P< 0.05) Greater exercise self-efficacy and better health-related quality of life.	Determining the cost-effectiveness of this intervention. Assessing the contribution of behaviour change strategies at individual level in generating change in PA.
Boodai et al., 2014	Kuwait	Obese adolescents (10-14 y.)	Assessor-blinded Randomized clinical trial	N=64	6 hours contact over 24 weeks, group-based to change sedentary behaviour, physical activity, and diet.	60 min low intensity PA session per time 6 sessions per 24 week	6 months	BMI Z-score WC BP	**No** significant difference between intervention group and control group at 6 months post intervention.	Although the intervention program is feasible, increasing adherence by adolescent is needed
Al-Haifi et al., 2012	Kuwait	Adolescent boys (15–18 y)	Interventional prospective study	N=14	Multicomponent intervention program (nutritional education + exercise + family support + peer group involvement, + motivation of participants)	60 minutes of moderate to vigorous exercise 3–5 times weekly	6 months	BMI	A significant weight loss (P = 0.001) Reduction in mean BMI (p<0.001)	Developing a specific media content is need as a strategy of weight loss via healthy eating and PA programs for children and adolescents. Promoting involvement of parent is key to the success of obesity prevention programs for teenager.
Al-Ozairi et al., 2018	Kuwait	Adults patients with type 2 diabetes (18–75 y.)	Two-arm parallel single-blind randomized controlled trial	N=572	Database of text messages supporting positive lifestyle changes in type 2 diabetes will be sent to participants	PA is an outcome	12 months	HbA1c and weight PA level Fasting lipids Quality of life	It is a study protocol. No results have been published yet.	
Habib-Mourad et al., 2014	Lebanon	School children (9–11 y.)	Pilot / feasibility study	N=387	Health-E-PALS Multicomponent school-based intervention program (class curriculum + family	Increasing moderate-to-vigorous physical activity (MVPA)	3 months	BMI WC Knowledge, PA Dietary habits	Significant reduction in consuming unhealthy food (chips and sweetened drinks) (p<0.05)	To implement the program for longer period at a larger scale including more schools from different regions of the country.

					involvement + food service)				Significant increase in knowledge and self-efficacy scores (p<0.001) No difference in physical activity and screen time habits and no changes in BMI Good acceptance of the intervention programme	
Bardus et al., 2018	Lebanon	Adults males and females (age not provided)	Single-center, parallel, randomized controlled trial with 2 study arms (intervention and control)	N=ranging between 181-305 (A protocol study)	Lark Pro application, including personalized health plan + nutrition coaching, + physical activity + weight + sleep + mood tracking	No specific physical activity intervention is designed	12 weeks	Absolute weight WC Physical activity Diet Motivation in participating in a weight management program	This was a study protocol. Results are not yet published	
Alghafri et al., 2018	Oman	Adult with type 2 diabetes (≥18 y.)	Cluster randomized controlled trial	N=174	'MOVEdiabetes' multicomponent intervention to increase physical activity (PA)	150 min of moderate-intensity Or 75 min of vigorous-intensity PA Or a combination of the two) per week (≥600 MET. min/ week)	12 months	MET (min/week) Daily step counts Sitting time weight BMI glycated hemoglobin BP Lipids	Very significant increase in MET (p=0.003) Odds to meet PA recommendations higher compared to control group (p=0.02) significant increased mean steps/day (p= 0.049) Significant decrease sitting time hours/ per day (p<0.001) Significant changes in SBP (p=0.04) and DBP (p= 0.001)	Effective intervention which provides cardioprotection to adults with T2D A cost analysis should be investigated.
Alghafri et al., 2017	Oman	Adult with type 2 diabetes (18 - 60 y.)	1:1 cluster randomized controlled trial	N=128	'MOVEdiabetes' multicomponent intervention to increase physical activity (PA)	150 min of moderate-intensity Or 75 min of vigorous-intensity PA	12 months	MET (min/week) Daily step counts Sitting time weight BMI glycated hemoglobin	This was a study protocol. Results are published by Alghafri et al., 2018	

						Or a combination of the two) per week (≥600 MET. min/ week)		BP Lipids		
Rashed et al., 2016	Occupied Palestinian Territories	Type 2 diabetes patients (31–70 y.)	Short duration observational study	N=215	Diabetes educational intervention program	No specific Physical intervention program is designed	4 hours educational program.	BMI. Blood FBS, HbA1c, Cholesterol TG Measured at baseline and after 3months	Significant decrease in BMI (p=0.000), FBS (p=0.049) and mean triglycerides (p=0.025)after educational intervention.	Diabetes education should be integrated in the health planning in the primary health care centers.
Mohamed et al., 2013	Qatar	Type 2 diabetes patients (mean age: 52 y. for intervention group; 55 y. for control group)	Randomized controlled trial	N=430	Culturally sensitive structured educational Programme (CSSEP)	Session on exercise benefits No PA intervention	12 months	BMI HbA1C FBS Lipid profile Microalbuminuria; KAP score	Significant reduction in BMI (0.001), HbA1C (p=0.012), FBS (P=0.022), Albumin/creatinine ratio (p<0.0001) Improved KAP (p= P=0.0001)	CSSEP is effective for type 2 diabetic patients. This intervention should be replicated in other Arab countries
Selmi et al., 2015	Qatar	Obese adolescents boys and girls (mean age: boys: 13 (0.9)y; girls : 12 (0.9)y)	Intervention program (3-day structured program)	N=32	The QDA, a 3-day structured program.	No PA intervention is designed	6 months	Motivational interviewing techniques to encourage participants toward behavior change.	No results are published yet.	
Al-Kuwari et al., 2016	Qatar	Adults male and female (Arab and other races) (Mean age: 41.3 y.)	Cross-sectional longitudinal study	N=970	The intervention is all about PA	To reach ≥10,000 steps and to keep it daily.	12 weeks	Number of steps Patterns of physical activity	Significant increase in average daily steps, considerably among females and older age group (≥45 years old) (P<0.001)	Pedometer program is effective and should be encouraged.
Adedeji et al.,2011	Saudi Arabia	Adult patients attending a lipid clinic (33 - 61 y.)	Retrospective analysis of the biodata	N=100	Dietary and lifestyle modifications	Exercise to reduce weight.	6 months	BMI BP Blood glucose Blood lipid levels Absolute reductions of risk category.	Significant Reduction in BMI; SBP and DBP, blood glucose, total cholesterol, LDL-cholesterol, TG and the absolute risk reductions. (p <0.05).	The effectiveness of this approach to manage CHD risk management is confirmed.
Alnasser et al., 2019	Saudi Arabia	Overweight volunteer Saudi women. (≥18 y.)	Pre-post single arm pilot study	N=240	Twazon Apps	60 min of moderate-intensity PA daily was recommended	4 months	Anthropometric Diet, PA Measures Frequency of app use System usability	Significant reduction in body weight 1.3 (SD 0.6) kg (P=0.18), WC (P<.001), daily energy consumption was decreased	Due to challenges in retention of participant, the use of mobile phone technology in weight reduction should be further explored.

									(P=.002). among participants engaged in Apps use	
Midhet and Sharaf; 2011	Saudi Arabia	Attendees of PHCCs (≥ 20y.)	Uncontrolled experimental study with a pretest and posttest design	N= 1011	A health education on: Smoking + diet + PA	No specific PA was designed	6 months	Dietary habits Exercising habits Smoking habits	Significant increase in fish and fresh vegetables consumption (p=0.001 and p<0.001, respectively) Significant decrease in consumption of bakery, dates (p<0.001). Increased exercise in males (p=0.005) Decreased smoking in males (p=0.001)	It is recommended to improve the quality of health education delivered to patients attending the PHCCs as this would increase the awareness and practice of healthy behaviours.
Sani et al., 2018	Saudi Arabia	Newly diagnosed diabetes mellitus Patients (≥18 y.)	Quasi-experimental two-group, pre- and post-evaluation study design	N=200	Multidisciplinary intervention program : "*Jizan Integrated Life Style Education (JILSE) Program*"	PA is part of health education program.	6 months	BMI Smoking habits PA and exercise Duration of disease Type of treatment, SBP DBP FBS Total cholesterol, triglycerides HDL LDL HbA1C Diabetic knowledge	Significant reduction in mean HbA1C, FBS, SBP, DBP, total cholesterol value. (p<0.05) No significant reduction in triglycerides, LDL, HDL, smoking habits, and physical exercise. (p>0.05)	Appropriate health education program and motivation to diabetic patients should be promoted as they influence positively on overall health
Alghamdi, 2017	Saudi Arabia	Saudi and Arab adult obese patients (males and females). (≥20 y.)	Randomized clinical trial	N=140	Intensive lifestyle intervention program (including PA)	Personalized PA intervention (based on the American Preventive Services Task Force guidelines)	12 week	BMI WC HC SBP DBP	Significant difference in the proportion of participants who achieved a ≥5% weight reduction between the AC and ILI groups (p=0.008). significant mean weight loss (p=0.002) reduced WC and HC (p<0.05)	Effectiveness of the intervention program in promoting weight loss among obese patients Such a program should be promoted in PHCC Long-term effectiveness and weight loss maintenance should be investigated.
Tomar and Allen, 2016	Saudi Arabia	Adult males (27-57 y.)	Randomized clinical trial (intervention study)	N=27	All the intervention is about PA	Two non supervised exercise sessions per week,	12 weeks	BMI Body Fat Percent SBP DBP RHR	Significant decrease in body weight (p=0.003), BMI (p=0.01), body fat percentage	Effectiveness of the intervention program is demonstrated.

						containing aerobic and resistance exercises.		FBS Lipid profile Depression Work Ability Index	(p=0.001), RHR (p=0.036), TC (p=0.027), LDL (p=0.016) and depression (p< 0.035) in university employees. No significant differences were obtained for WAI, HDL, VLDL, TG, FBS and BP	
Al-Hamdan at al., 2019	Saudi Arabia	Pre-diabetic overweight or obese females (18–55 y.)	Interventional study	N=123	Intensive lifestyle modification intervention delivered in PHCC	PA was part of the education program PA monitoring every 2 weeks for 3 months	6 months	BMI WHR SBP DBP HbA1c Lipid Profile Energy Intake Macronutrients intake	Significant improvement in HbA1c (p < 0.001); in overall energy intake (p< 0.001), total cholesterol (p <0.04) and HDL (p< <0.001) No significant changes in BMI and weight.	Effective program for pre-diabetic patients Long-term effectiveness should be investigated.
Alzeidan et al., 2019	Saudi Arabia	Saudi pre-diabetic adults male and female (≥ 18 y.)	Randomized control trial	N=1016	Education about lifestyle modifications + written information about diet and physical activity + Text message (SMS)	Education on PA + text message on PA (no specific intervention is designed)	3 years	BMI WC BP HbA1c Fasting lipid profil Dietary adherence Metabolic Syndrom PA PA adherence	It is a study protocol. No results have been published yet.	
Altwaijriet al., 2019	Saudi Arabia	Adult male and female Saudi (21- ≥60 y.)	Interventional pre-post longitudinal design	N=53	Wellness program with different modules	A module of “fitness Warm up”, including: For Males: a group walk + 2 medium intensity workouts For Females: fitness sessions given by a female instructor + and a brief session providing expert tips on fitness and well-	6 months	PA Diet Work productivity Absenteeism, Workplace satisfaction Stress	Significant amelioration in physical functioning (p=0.004) Significant increase in average intake of water/d (p=0.01) and fruit (0.03)consumption, Significant decrease in of soft drinks consumption (p=0.02) Significant reduction absenteeism (p=0.02)	A successful program at short-term. Barriers faced by participants to enroll a wellness program should be considered when tailoring it.

being.

Hamila et al., 2018	Tunisia	Overweight and obese adolescents boys and girls (13 - 15 y.)	Walking rehabilitation programs (random clinical intervention program)	N=31	A rehabilitation program	Walking for two month-duration, 3 session/week for at least 60 min/ session 3 intervention groups : 1- walking at 70% MAS 2- waking at 50% MAS 3- Self-selected walking pace group (SSWP) + Control group (C)	2 months	Body Mass BMI BMI Z-Score WC HC W/H ratio Body fat Maximal Aerobic speed Maximal fat oxidation Heart rate availability (HR)	Decrease in body mass (P<0.01), BMI (P<0.01), and body fat (P<0.05) in 50%MAS, 70%MAS, and SSWP groups Significant increase in calculated maximal fat oxidation in all the intervention groups. (p <0.01) Significant decrease in HR values during the recovery period (p <0.05) Significant increase in indices of heart rate variability in 50%MAS and 70%MAS groups (p <0.05).	Rehabilitation programs are effective in reducing obesity and overweight.
Maatoug et al., 2015	Tunisia	School age children (11 - 16 y.)	Quasi-experimental school-based intervention	N=4 003	School-based intervention (PA + healthy eating program)	Educational lessons on the benefits of regular physical activity, and how it can be incorporated into daily activities (60 min for ≥3 days/ week + peer education via training of schoolchildren leaders	3 years intervention	Physical activity	Increase in number of students in the normal weight category (p =0.03) Decrease in number of students in the overweight category. (p =0.03) Significant increase in fruit and vegetable intake. (p=0.04)	School-based intervention is successful in increasing healthy dietary habits and in reducing risk of excess weight. The emphasis is made on the importance of a multi-sectoral approach promoting environment toward healthy behaviors for adolescents.
Maatoug et al., 2017	Tunisia	Overweight and obese school age children (13.1 y. in intervention group; 13.5 y. in control group)	Quasi-experimental study school-based intervention	N= 314	School-based intervention (PA + healthy eating program)	A program of twice a week PA sessions, which was then adapted to the capacity and preferences of participants	One academic year	BMI Z score PA Energy expenditure (kcal/day) Calorie intake Lipids intake Carbohydrates intake Proteins intake	Significant decrease in the BMI Z score in the intervention group. (p < 0.001) Significant decrease in calorie intake in intervention and control groups (p<	This project introduced a new idea of health management in schools and focused on increasing on the awareness of the importance of obesity prevention and treatment.

									0.05)	Emphasize on the importance of support of authorities for this type of action made to ensure its sustainability.
Maatoug et al., 2013	Tunisia	Adolescents (12-16 y.)	Quasi-experimental intervention study with two groups: control and intervention group	N=1247	School-based intervention (PA + healthy eating program)	Interactive lessons and activities on the role, benefit of PA and how to engage in it.	One academic year	Knowledge Behaviours Intentions about dietary habits and physical activity.	Significant increase in the post-test knowledge intention and behavioral intention compared to control group. ($p<0.01$)	Improvement of healthy behaviour (eating and PA) was obtained among School-aged children. Individual circumstances for each individual should be taken into account to ensure the intervention success.
Bhiri et al., 2015	Tunisia	Adult males and females (18 – 64 y.)	Quasi-experimental study (pre- and post-assessments with intervention and control groups)	N=1775	Education program on tobacco , diet and PA	Free physical activity sessions, + Affording physical activity facilities at the workplaces	3 years	Eating habits, PA habits, Tobacco use habits	Considerable improvement among the employees toward dietary ($p<0.05$) and physical activity ($P < 0.001$) behaviors No changes in tobacco use habits.	To take benefit from the workplace as an important a setting for health promotion. Involvement of multi-sectoral approach should be considered to control the main NCD risk factors.
Sahli et al., 2016	Tunisia	Adult males and females (mean age: 37.20 y. in intervention group; 38.6 y. in control group)	Quasi-experimental study	N=1941	Education program on tobacco , diet and PA	No specific details for PA intervention	3-year community intervention	Attitude and beliefs toward risk factors of NCD (diet, tobacco and PA) BMI WC BP	SBP ($p=0,001$) DBP ($p=0.035$) reduction in intervention group After stratification of age, significant decrease in prevalence of hypertension mostly among participants younger than 40 years old. ($p=0.007$) After stratification of weight, significant decrease in prevalence of hypertension mostly among nonobese participants	Feasibility and effectiveness of a community-based intervention is demonstrated in terms of reduction of prevalence of hypertension.

									(p=0.03)	
Ghammam et al., 2017	Tunisia	Adolescents (11 to 16 y.)	Quasi experimental study	N=4700	Educational intervention program promoting healthy life, including PA.	No specific details of PA	3 years of intervention + 1 year follow up	BMI Fruits and vegetables consumption PA habits Smoking habits	Significant increase in prevalence of adolescents consuming 5 fruits and vegetable per day(p=0.02) from pre-assessment to post assessment and one year after (p=0.41) Decreased trend of smoking habits at pre-assessment, post-assessment and follow-up in the intervention group (p=0.19, p=0.25) Significant decrease (p=0.01, p=0.001 respectively) in school children who did recommended physical activity in the intervention group *(could be due to the occurrence of the Tunisian Revolution in the middle of the project)*	Designing, conducting and evaluating strong preventive interventions in developing countries should be promoted.
Stanley et al., 2017	United Arab Emirates	Adolescents males and females Mean age: 13.9 y.	Intervention cohort study	N=394	Workshops as health education intervention by peer approach (on tobacco and nutrition/PA)	Health education workshop on PA.	No detailed PA intervention was designed	Knowledge Attitudes Perceptions	No changes in knowledge, attitudes and perceptions of nutrition and physical activity were obtained. Changes obtained after tobacco workshop	Effectiveness of peer-mediated health workshops should be investigated further by targeting local populations in their native language. This types of initiatives could be used to increase legislation efficacy and implementation of laws designed to encourage a healthier lifestyle.
Hasan et al., 2018	United Arab Emirates	Adult females (mean age 21.43 y.)	Quasi-experimental pretest-posttest study	N=52	PA intervention	Walking 10,000 steps per day, using a pedometer + Educational	9 weeks	BMI WC HC Body weight BFM PBF	Significant improvement in BMI , BFM, and WHR in Normal BMI group. (p<0.05)	Using a pedometer could be considered as an effective and safe approach and motivational

						material on PA		VFA FFM BP T-Chol, TG, HDL LDL Fasting glucose levels Serum insulin Metabolic syndrome score Nutrient Intake	Significant decrease in PBF, WC, VFA, TG ($p = 0.003$) insulin ($p = 0.046$) and increase in HMW-Adip ($p=0.034$) in high BMI group. A positive correlation with SBP ($r=0.46$, $p=0.011$), DBP ($r=0.39$, $p= 0.031$) and inverse correlation with the MetS score ($r= −0.5$, $p=0.005$) were obtained. A significant inverse correlations between daily footsteps and BMI ($r =−0.33$, $p = 0.017$), BFM ($r =−0.29$, $p=0.037$) , WHR ($r=−0.401$, $p= 0.003$) , and MetS score ($r= −0.49$, $p<0.001$) and positive correlation with HMW-Adip were obtained. ($r = 0.331$, $p=0.017$).	instrument to encourage a healthy and active lifestyle and to fight the development of Metabolic syndrome.
Sadiya et al., 2016	United Arab Emirates	Adult men and women obese or obese with T2D (Mean age: 42 y.)	Intervention program	N=28	Lifestyle Program intervention	A structured exercise session 2 times/week (45 min) = aerobic exercises + strength training + stretching exercises In addition, participants were recommended to perform moderate-intensity physical activity between 150-250	3 months (12 weeks)	FBG HbA1c, BP Body composition WC Dietary intake, PA habits Nutritional knowledge	Reduction in body weight (95% CI 3.7–5.8, fat mass ($P<0.01$) and WC ($P<0.01$) Significant improvement in HbA1c and FBG. ($p<0.05$) Significant increase in nutritional knowledge ($p<0.01$) Weight loss maintenance on 1-year follow-up Improvement in	Effectiveness, affordability, acceptability, and adaptability of lifestyle intervention program is demonstrated in terms of prevention and management of diabetes in UAE. Further investigations involving larger sample size and other health care centres are recommended.

						minutes/week or a step count of 7,000–10,000/day.			FBG obese and type 2 diabetic participants on 1-year follow-up. ($p<0.05$)	
Dalibalta et al., 2017	United Arab Emirates	Adults males and females (19–23 y.)	Exercise intervention program	N=46	PA interventional study	60 min of moderate-high intensity exercise, 3 times/ week.	8 weeks	BMI Cardiorespiratory fitness T-chol HDL TG WHR BP Arterial stiffness	Significant improvement in biochemical variables Significant improvement in overall fitness ($p < 0.05$) Decrease in WHRs and BMI ($p < 0.05$) Increase in peak oxygen volumes ($p < 0.05$) Unexpected increase in SBP in overweight/obese participants ($p < 0.05$). Clear increase in HDL ($p < 0.05$)	Short-term exercise reduces CVD risk factors. Further studies with larger sample size and longer duration of the exercise intervention is needed.

Abbreviation

BFM:	Body Fat Mass
BMI:	Body Mass Index
BMR:	Basal Metabolic Rate
CHD:	Coronary Heart Disease.
DBP:	Diastolic Blood Pressure
FBS:	Fasting Blood Sugar
FFM:	Fat-Free Mass
FM:	Fat Mass
HADS:	Hospital Anxiety and Depression Scale
HB	Hemoglobin
HDL:	High Density Lipoprotein
HMW-Adip:	High-Molecular-Weight Adiponectin
HP:	Hip Circumference
HR:	Heart Rate
LDL:	Low Density Lipoprotein
MAS:	Maximal Aerobic Speed
METs :	Metabolic Equivalents
NCD:	Non-Communicable Diseases
PBF:	Percentage of Body Fat
PHCCs:	Primary Health Care Canter
RHR:	Resting Heart Rat
SBP:	Systolic Blood Pressure
T2D:	Type 2 Diabetes
T-Chol:	Total cholesterol
TG:	Triglycerides
VFA:	Visceral Fat Area
WAI:	Work Ability Index
WC:	Waist Circumference
WHR:	Waist/ Hip ratio