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# Physical Activity Patterns Associated with Lifestyle, Diet, and Body Mass Index in a Sample of Young Adults

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**Abstract**

**Objective:** The assessment of practices conducted in leisure time and daily life is fundamental to improving lifestyle behavior and community health. The purpose of this study was to examine lifestyle and its correlation with the pattern of leisure-time physical activity (LTPA) among adult Saudis.
**Material and Methods:** In total, 150 adult Saudis (ages 15–22 years) participated in this study. The participants were personally interviewed to gather information regarding sociodemographics, physical activity (PA) patterns [denoted as metabolic equivalents (METs)] determined using the Global Physical Activity questionnaire (GPAQ), and lifestyle factors (assessed using the Stevan Cordas Stress Questionnaire). Cronbach's coefficient alpha ($\alpha$), Pearson's r, and Spearman's rho statistics were evaluated to determine the test–retest reliability of the stress questionnaire among the participants.
**Results:** The median total LTPA was 7333 METs-min/week for both genders. Males had a higher LPTA versus females (3945 METs vs. 3387 METs, respectively). Using a cutoff of 600 METs-min/day or 150 min each day for 5 days/week of moderate PA, only 38.0% of participants reported no leisure activity, 62.0% reported high PA, and 72% reported moderate PA. In participants with moderate to high PA, there were correlations between a decrease in body mass index, lifestyle, and an increase in diet and calcium intake ($p<0.001$). Correlation analysis showed that being a male with moderate PA was related to activity to a greater extent than this relationship in females.
**Conclusion:** Nearly 38% of the sampled population did not achieve the recommended LTPA level for beneficial health effects. The highly active participants comprised 62% of the total sampled population, and substantially more of these were males (60.0% vs. 2.0% females). These data suggest that Saudi adults should change their lifestyle by increasing food intake and PA to achieve optimal health status.
**Keywords:** Adrenal fatigue, lifestyle, physical activity, calcium intake, severity index, BMI

## Introduction

Familial obesity largely depends on lifestyle (1). The unfolding population epidemic, similarly, has underscored the importance of factors in the environment that have recently resulted in dramatic changes to risk over relatively short periods of time (2). The risk factors for obesity include biological susceptibility and environment, although interactions between these factors are complicated and remain unclear. Therefore, the assessment of phenotypic behavioral typologies that may potentially predict obesity risk is needed to enhance our understanding of risk factors related to the onset of obesity (3).

Numerous variations in biological and environmental interactions are suggested to be risk factors for the onset of obesity. The variables most consistently associated with obesity risk are lifestyle issues such as where and what people eat (e.g., fast food, sugar-sweetened beverages, and watching TV), when they eat (e.g., meal skipping), and intentional weight management practices (e.g., self-weighing and meal planning) (4,5).

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Lifestyle behaviors associated with eating and intentional weight control behaviors. Recent research highlights the importance of considering unique relationships between behavioral practices and multiple aspects of weight change associated with obesity (6). Nutrition is an important modifiable factor in the development and maintenance of bone mass. Approximately 80–90% of bone mineral content comprises calcium and phosphorus (7). Other dietary components such as magnesium, zinc, copper, iron, fluoride, and vitamins D, A, C, and K are required for normal bone metabolism (8). These nutrients occur together in foods, and their intake can be detected by assessing dietary patterns and by measuring food group intake. Previously, it was reported that during adolescence, milk products are the principal source of dietary calcium (61%) and that grain products (9%), vegetables and fruits (7%), meat and alternatives (2%), and other foods (21%) contribute smaller proportions (9). Although most studies have focused on the effects of calcium, the intake of milk products, or both on bone accrual (10,11), the role of dietary vegetables and fruits is also emerging as an area of research interest. For example, a cross-sectional study reported a positive link between the consumption of fruits and vegetables and bone mineral density (BMD) in 10-year-old females (12).

Adequate intake of calcium is extremely important for achieving optimal bone mass and reducing the rate of bone loss due to aging. The main function of vitamin D is to maintain serum calcium and phosphorus concentrations within the normal range by increasing the efficiency of the small intestine to absorb these minerals from food. Vitamin D is mainly derived from milk and other dairy products (13).

Sedentary habits contribute to a substantial portion of deaths related to coronary heart disease, type 2 diabetes, and colon cancer (14). However, regular physical activity (PA) helps preserve functional abilities and maintain independent living in older adults (15). Accordingly, understanding the causes of inactivity may aid in the development of effective programs to increase PA levels to meet public health recommendations through moderate-intensity physical exercise training (16). Regular physical activity is associated with a lower risk for the development of chronic diseases such as cardiovascular disease, diabetes mellitus, and obesity (17). The benefits of PA are particularly important for older adults because 88% of adults aged ≥65 years have at least one chronic health condition (18).

The prevention of non-communicable diseases depends on controlling modifiable risk factors, which includes physical inactivity [PinA; a behavior in which individuals do not engage in any leisure-time PA (LTPA)]. According to estimates from the World Health Organization (19), PinA accounts for almost 2 million deaths globally. Physically inactive individuals have a 20–30% increased risk of all-cause mortality compared with individuals who adhere to 30 min of moderate-intensity PA for most days of the week (20). Furthermore, PinA may be responsible for 21.5% of ischemic heart disease cases, 11% of ischemic stroke cases, 14% of diabetes cases, 10% of breast cancer cases, and 16% of colorectal cancer cases (21). PinA, both in the short and long term, is also associated with higher levels of BMD loss (22). However, moderately intense training may contribute to increased accrual of bone mineral in young individuals (23).

The prevalence of PinA amongst individuals residing in transitional countries is in the range of 29.6–31.8% of all individuals (24). LTPA refers to exercise, sports, or recreation that is not related to regular work, housework, or transport activities (25). LTPA was shown to be positively associated with the likelihood of having a normal body mass index (BMI) and lower body fat range. In contrast, sedentarism or leisure-time physical inactivity is associated with arterial hypertension and diabetes as well as an increase in the number of hospital admissions (26). LTPA has been studied using epidemiological surveys in developing countries; PinA is overestimated because other types of PA have not been evaluated (27).

Saudi Arabia has witnessed enormous economic advancement in recent decades. This transition has promoted the adoption of westernized dietary habits and a sedentary lifestyle, which in turn has a considerable negative impact on community health. These changes are thought to be important contributors for a recent epidemic of non-communicable diseases and their complications. A community-based study in the Kingdom of Saudi Arabia (KSA) reported that the overall prevalence of coronary heart disease and diabetes mellitus was 5.5% and 23.7%, respectively (28). Moreover, according to the National Cancer Registry Report, breast cancer represented 12.9% of all cancers among the Saudi population, with an age-specific incidence rate of 11.8/100,000 among adult Saudi females (29). Breast cancer incidence is predicted to continue rising in response to changes in lifestyle of the Saudi population, particularly in relation to the lack of PA (30). Additionally, colorectal cancer is now the first and third most common cancer among males and females in Saudi Arabia, respectively. The age-standardized rate of colorectal cancer has progressively risen over the last few decades; this rise is attributed to an increase in predisposing factors including PinA (31).

Several population-based studies examining the prevalence of LTPA in Saudi Arabia have not been able to elucidate a recognizable pattern of PA among different domains (32). Published reports on the PA profile of Saudi adults indicated that the majority of Saudi people are not physically active enough to achieve health benefits from PA. Knowledge about the prevalence of LTPA and its determinants may serve as the basis for establishing interventions that encourage LTPA in diverse populations. Therefore, generating data that may be useful for the development of public policies designed to prevent physical and mental comorbidities is important (33). According to prior research studies, lifestyle and health behaviors tend to be interrelated (34,35). The objectives of this study were to determine the patterns of PA among adult Saudis and to define sociodemographic lifestyle determinants that correlated with sufficient levels of PA in the population of Al-Riyadh, Saudi Arabia (KSA).

## Material and Methods

### Participants

In this cross-sectional study, supervised experienced data collectors collected the data in 2013–2014. The research team recruited 150 voluntarily registered participants, aged 15–22 years, and obtained detailed sociodemographic data from each participant. All participants were informed verbally and in writing about the aim of the study before they gave informed consent and completed the questionnaire. The study was approved by the Local Ethics Committee of Rehabilitation Research Chair (RRC), King Saud University, Riyadh, KSA. The basic characteristics of the participants are shown in Table 1.

### Measures

### Sociodemographic Attributes

Gender, age, education level, employment status, marital status, living conditions, and household income levels were assessed using a self-administered questionnaire. We collected data on education level (graduate school, university, two-year university, career college, high school, or junior high school), employment status (office worker, independent businessman, professional, public official, student, housewife, part-time worker, or unemployed), marital status (married or unmarried), and living conditions (number of cohabiters or living alone).

### Physical Activity

The Global Physical Activity Questionnaire (GPAQ) version 2.0 was used for data collection, and this was accompanied by a show card derived from the World Health Organization STEP-wise approach to Chronic Disease Risk Factor Surveillance instrument version 2.0 (WHO STEPs, http://www.who.int/chp/steps/GPAQ/en/index.htm), which provides examples of the types and intensity of PA, with some modifications to suit the Saudi community (GPAQ, http://www.who.int/chp/steps/GPAQ/en/index.htm). The questionnaire assesses the frequency (days) and time (min/h) spent in moderate-to-vigorous-intensity PA during a typical week in the following three domains: a) work-related (paid and unpaid, including household chores), b) transportation (walking and cycling), and c) LTPA. GPAQ is derived from the International Physical Activity Questionnaire (www.ipaq.ki.se) that is valid and widely employed to assess PA patterns. Previous studies showed that GPAQ has a good test–retest repeatability and relative validity [Bull et al. (21); Trinh et al. (36)]. We translated the original content of GPAQ into Arabic, followed by back-translation into English to ensure reliability of the questionnaire. No changes were made to the original content or the wording of the questionnaire. The LTPA questionnaire covered the following activities: walking (light and intense), running, biking (light and intense), swimming (light and intense), tennis, football, basketball, handball, martial arts, aerobics-gym, weightlifting, workout with apparatus, and others. One male and one female data collector were recruited for data collection; they received training on a) Conducting an interview, b) How to use the show card, and c) Checking the quality of the collected data under the supervision of investigators.

### Estimation of Energy Expenditure

Energy expenditure was estimated based on the duration, intensity, and frequency of PA performed in a typical week. The unit of measurement for energy expenditure was the metabolic equivalent (MET) derived from the activity variables of GPAQ. MET is the ratio of specific PA metabolic rates to the resting metabolic rate. One MET is equal to the energy cost of sitting quietly (1 kcal/kg/min), and oxygen uptake in ml/kg/min for 1 MET is equal to the oxygen cost of sitting quietly (approximately 3.5 mL/kg/min). MET values and formulae for computation were based on the intensity of specific PA as follows: a) Moderate-intensity activity during work, transportation, and leisure assigned a value of 4 METs; b) Vigorous-intensity activities assigned a value of 8 METs; and c) Total PA score was the sum of all METs/min/week derived from moderate-to-vigorous-intensity PA performed during work, transportation, and recreation. According to the GPAQ analysis framework, PA is classified into the following levels:

**High**: Includes (a) vigorous-intensity activity on at least 3 days, each day equaling at least 1500 METs-min/week or (b) ≥7 for any combination of walking and moderate-or-vigorous-intensity activities with at least 3000 METs-min/week.

**Moderate**: Includes (a) ≥3 days of vigorous-intensity activity for at least 20 min/day, (b) ≥5 days of moderate-intensity and/or walking for at least 30 min/day, or (c) ≥5 days of any combination of walking and moderate-or-vigorous-intensity activities with at least 600 METs-min/week.

**Low**: No activity reported, or reported activities did not comply with the previous criteria.

The previous three levels were re-categorized into the following categories:

**Highly active**: Vigorous activities ≥3 days and accumulating to ≥1500 METs-min/week or ≥7 days of any combination of moderate or vigorous activities accumulating to ≥3000 METs-min/week.

**Moderate active**: Participants who met the PA recommendations of “being in the moderate- or high-intensity categories” or who met the minimum recommendations of 30 min of moderate-intensity LTPA for ≥5 days/week or MET-min/week of ≥600 in the classification of LTPA (International Physical Activity Questionnaire, www.ipaq.ki.se).

**Low active:** In the low category. In GPAQ, no PA during work, transportation, and leisure was determined based on the yes/no questions for each domain.

### Lifestyle Factors

The lifestyle status of the participants was identified using the Stevan Cordas stress questionnaire (http://www.drcordas.com/education/questionnaires/STRESSQr.pdf). This questionnaire is based on surveying five general types of stress-causing mechanisms that cause illness. These are (a) nutritional and metabolic, (b) emotional or psychological, (c) allergic and other environmental factors, (d) structural, and (e) genetic and biochemical. This questionnaire is designed to quickly assess these areas and guide physicians in the direction of further enquiry. A score of ≤150 suggests no stress, 150–250 suggests moderate stress, and ≥300 suggests significant stress problems.

**Test–Retest Reliability of the Stress Questionnaire**

Seven-day test–retest reliability was applied in two moments (test–retest), with an interval of 7 days between the two assessments (time 1 and 2). Internal consistency was calculated using Cronbach's coefficient alpha (α) for five general types of stress-causing mechanisms that cause illness (nutritional and metabolic, emotional or psychological, allergic and other environmental factors, structural, and genetic and biochemical). The 7-day test–retest reliability was estimated using Pearson's r and Spearman's rho statistics. It has been suggested that test–retest reliability coefficients ≥0.80 for these statistics are indicative of acceptable test–retest reliability (37). All statistics were calculated for the entire sample as well as separately according to gender.

**Evaluation of Diet**

All participants were evaluated for diet as well as tobacco and alcohol intake. The evaluation of diet included recording the daily consumption of calcium-containing foods (e.g., milk, cheese, and yogurt) and cola beverages. Dietary information was obtained from food diaries or by extensive dietary interviews, which were conducted by the data collectors. The same person coded and checked all forms and analyzed dietary intake data according to procedures described elsewhere (38).

**Severity Index**

The Severity Index was calculated by dividing the total points by the total number of questions answered by each participant in the affirmative. This test gives an indication of how severely a participant experiences signs and symptoms, with ≤1.0 being normal, 1.0–1.6 being mild, 1.7–2.3 being moderate, and ≥2.4 being severe (39).

**Statistical Analysis**

All data are reported as means ± standard deviation (mean ± SD). Repeated measures analysis of variance (ANOVA) using a Bonferroni correction for multiple comparisons was used to assess data that were normally distributed. Wilcoxon rank-sum tests and Student's t-test were used to assess nonparametric data. An exploratory factor analysis for the items of lifestyle and severity scores was conducted to identify the common components of the scale that effectively responded to PA traits. The estimation of daily calcium intake was positively biased and was corrected by its own square root (√x) before it was used in the subsequent analyses. The Pearson correlation coefficient (r) was used to assess relationships between physical traits, lifestyle, BMI, and daily calcium intake. We set the alpha at 0.05 to determine statistical significance. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) statistical package 16.0 for Windows (SPSS Software, Inc., Chicago, IL, USA).

**Table 1. Demographic characteristics of the study sample (n=150)[1]**

| Variables | Males (n=125) | Females (n=25)[2] |
|---|---|---|
| Age, (years) | 18.98±2.247 | 20.32±1.97 |
| Height, (cm) | 169.1±9.25 | 173.1±3.5 |
| Weight, (kg) | 67.7±13.42 | 70.24±3.1 |
| BMI, (kg/m$^2$) | 23.7±4.45 | 24.9±1.56 |
| **Educational level (no., %)** | | |
| ≥4 years of university | 25 (20%) | 5 (20%) |
| 2 years of university | 65 (52%) | 8 (32%) |
| High school or junior high | 35 (28%) | 12 (48%) |
| **Employment status** | | |
| Employed | 40 (32%) | 5 (20%) |
| Unemployed | 85 (68%) | 20 (80%) |
| Walking, min/week | 52.5±87.1 | 24.6±72.31 |
| Moderate-intensity activity, min/week | 105.12±108.7 | 98.4±99.8 |
| Vigorous-intensity activity, min/week | 13.92±46.03 | 65.4±99.5 |
| Total physical activity (MET-min/week) | 3945.2±80.6 | 3387.54±90.53 |
| **Physical activity level** | | |
| Low (<600 MET-min/week) | 10 (8%) | 9 (36%) |
| Moderate (≥600 MET-min/week) | 25 (20%) | 13 (52%) |
| High (≥3000 MET-min/week) | 90 (72%) | 3 (12%) |

[1]All values are expressed as the mean±SD or no. (%)
[2]Significantly different from males (two-sided unpaired Student's t-test), p<0.05

## Results

Table 1 shows the characteristics of the participants. For all study participants, the mean age (standard deviation; SD) was 18.98 (2.25) and 20.32 (1.97) for males and females, respectively. The height, weight, and BMI of females were greater than those of males (p<0.05). From all participants, 40% individuals had higher educational qualifications, and 52% were employed. The mean time spent walking per week was 52.5 (87.1) min for males and 24.6 (72.31) min for females. Males spent 105.12 (108.7) min on average on moderate-intensity activity, excluding walking per week, whereas females spent 98.4 (99.8) min on the same. For vigorous-intensity activity, males spent 13.92 (46.03) min, whereas females spent 65.4 (99.5) min. The total PA (MET-min/week) for males was significantly higher (3945.2±80.6; p<0.05) than that for females (3387.54±90.53).

We found that low level of PA was reported by 44.0% of participants (36.0% for females vs. 8% for males, p=0.001), with a significant negative trend related to age and within females. Moderate levels of PA were reported in 72.0% of the participants, where moderate PA was more prevalent among females

**Table 2. Stress-Q means (standard deviation) of continuous measures and percentages (N) for participants at Time 1 and Time 2 with a 1-week interval**

| | | Full sample (n=150) | | Males (n=125) | | Females (n=25) | |
|---|---|---|---|---|---|---|---|
| **Section of the stress questionnaire** | **Items** | **Time 1** | **Time 2** | **Time 1** | **Time 2** | **Time 1** | **Time 2** |
| Emotional or psychological factors | 14 | 1.24 (1.14) | 1.8 (1.9) | 1.57 (1.09) | 1.7 (1.98) | 1.41(1.16) | 1.30 (1.18) |
| Genetic and biochemical factors | 15 | 1.80 (1.36) | 1.9 (1.44) | 1.35 (1.24) | 1.38 (1.4) | 1.27 (1.33) | 0.89 (1.49) |
| Allergic and other environmental factors | 13 | 1.39 (1.35) | 1.45 (1.6) | 0.87 (1.07) | 1.98 (1.21) | 0.75 (1.4) | 1. 5 (1.86) |
| Nutritional and metabolic factors | 16 | 1.27 (1.05) | 1.32 (1.45) | 0.95 (0.85) | 1.58 (1.61) | 0.58 (1.62) | 1.2 (1.5) |
| Structural factors | 17 | 1.71 (4.14) | 2.05 (6.29) | 1.7 (2.76) | 1.90 (1.80) | 1.41 (3.19) | 1.52 (2.70) |
| Overall | 75 | 2.02 (4.28) | 2.41 (4.41) | 1.98 (2.75) | 2.8 (3.34) | 1.3 (4.31) | 2.3 (5.33) |

**Table 3. Cronbach's coefficient alpha values for stress-Q subscales from participants at times 1 and 2 with a 1-week interval**

| | | Full sample (n=150) | | Males (n=125) | | Females (n=25) | |
|---|---|---|---|---|---|---|---|
| **Section of the stress questionnaire** | **Items** | **Time 1** | **Time 2** | **Time 1** | **Time 2** | **Time 1** | **Time 2** |
| Emotional or psychological factors | 14 | 0.73 (0.64-0.87) | 0.83 (0.60-0.87) | 0.75 (0.68-0.89) | 0.85 (0.60-0.87) | 0.75 (0.73-0.81) | 0.81 (0.60-0.87) |
| Genetic and biochemical factors | 15 | 0.79 (0.63-0.96) | 0.86 (0.66-0.86) | 0.81 (0.63-0.86) | 0.88 (0.66-0.90) | 0.79 (0.60-0.87) | 0.89 (0.66-0.90) |
| Allergic and other environmental factors | 13 | 0.87 (0.66-0.97) | 0.92 (0.55-0.95) | 0.79 (0.65-0.87) | 0.95 (0.65-0.95) | 0.87 (0.65-0.89) | 0.93 (0.65-0.95) |
| Nutritional and metabolic factors | 16 | 0.82 (0.66-0.86) | 0.87 (0.68-0.97) | 0.82 (0.61-0.86) | 0.88 (0.68-0.97) | 0.83 (0.72-0.86) | 0.89 (0.68-0.91) |
| Structural factors | 17 | 0.89 (0.55-0.95) | 0.90 (0.82-0.92) | 0.85 (0.62-0.92) | 0.91 (0.82-0.92) | 0.91 (0.88-0.93) | 0.92 (0.82-0.95) |
| Overall | 75 | 0.92 (0.66-0.97) | 0.93 (0.86-0.95) | 0.91 (0.72-0.97) | 0.96 (0.86-0.98) | 0.90 (0.72-0.97) | 0.93 (0.86-0.98) |

than males (52.0% vs. 20.0%, p=0.001). However, we found that males had a higher level of PA than females (72.0% vs. 12.0% for females, p=0.001). Overall, highly active participants represented 62% of the total sampled population, and substantially more of these were males (60.0% vs. 2.0% of females).

Table 2 shows the means and SDs for the stress questionnaire outcomes. Stress parameters measured in all participants indicated significantly higher means and SDs at both time points. However, males showed a significantly greater change in total lifestyle measures (mean=1.98 and 2.8 for times 1 and 2, respectively) than females (mean=1.3 and 2.3 for times 1 and 2, respectively).

Table 3 shows Cronbach's $\alpha$ internal consistency for all lifestyle stress measures. Internal consistency was acceptable for all measures. Overall, internal consistency was lower at time 1 than at time 2, which remained acceptable at both time points for both males and females. Internal consistency was consistently higher for males ($\alpha$=0.91 and 0.96 for times 1 and 2, respectively) than females ($\alpha$=0.9 and 0.93 for times 1 and 2, respectively).

Table 4 shows the test–retest reliability coefficients for the stress-Q measures. The test–retest reliability was strong for all lifestyle measures (Pearson's r=96; Spearman's rho=0.89). However, the test–retest reliability status for measured lifestyle parameters was better for males (Pearson's r=98; Spearman's rho=0.96) than females (Pearson's r=99; Spearman's rho=0.85) at the two assessment times (times 1 and 2). Thus, the data showed strong reliability for the questionnaire, with better results for investigating lifestyle among the studied participants.

Table 5 shows the results of lifestyle stress influences, including emotional, genetic, biochemical, structural, nutritional, metabolic, and allergic and other environmental factors on LTPA status (LTPAS). Total lifestyle stress appeared to directly affect the score of PA in all stages (low, moderate, and high status). Participants with low PA showed higher lifestyle stress influence than those who had moderate and high LTPAS levels. However, the data differed according to gender, with all LTPAS levels showing a significant increase in total life stress influence in females compared with that in males. Additionally, the data showed that nutritional and metabolic factors, followed by genetic, biochemical, and emotional factors, comprised the most effective parameters for the status of LTPAS levels among the participants.

Table 6 shows that most participants had an appropriate intake of milk products; however, females consumed less milk products than males (p<0.05). Gender differences were also observed for the intakes of meat and alternatives (Table 2). In males, the mean intake of all food groups was significantly greater than that in females (p<0.001; Table 2). Most participants consumed fewer vegetables and fruits than the recommended amounts. In contrast, >40% of the participants consumed a

**Table 4. Test–retest reliability for stress-Q measures for participants with an interval of 7 days between the two assessments (times 1 and 2)**

| Section of the stress questionnaire | Items | Full sample (n=150) | | Males (n=125) | | Females (n=25) | |
|---|---|---|---|---|---|---|---|
| | | Pearson's r | Spearman's rho | Pearson's r | Spearman's rho | Pearson's r | Spearman's rho |
| Emotional or psychological factors | 14 | 0.81 | 0.82 | 0.89 | 0.81 | 0.82 | 0.86 |
| Genetic and biochemical factors | 15 | 0.9 | 0.80 | 0.88 | 0.93 | 0.81 | 0.81 |
| Allergic and other environmental factors | 13 | 0.86 | 0.91 | 0.92 | 0.85 | 0.87 | 0.90 |
| Nutritional and metabolic factors | 16 | 0.89 | 0.85 | 0.91 | 0.89 | 0.90 | 0.88 |
| Structural factors | 17 | 0.87 | 0.92 | 0.85 | 0.80 | 0.82 | 0.80 |
| Overall | 75 | 0.96 | 0.89 | 0.98 | 0.96 | 0.91 | 0.85 |

**Table 5. Levels of leisure-time physical activity in relation to lifestyle and sociodemographic variables[1]**

| Variables | Males (n=125) | | | Females (n=25)[2] | | |
|---|---|---|---|---|---|---|
| | Leisure-time physical activity | | | Leisure-time physical activity | | |
| | Low | Moderate | High | Low * | Moderate* | High ** |
| Total lifestyle stress score | 280.4±87.13 | 255.7±117.45 | 245.6±116.14 | 319.16±43.5 | 299.5±37.7 | 290.5±31.2 |
| Emotional or psychological factors | 50.34±25.34 | 45.3±29.7 | 38.82±27.8 | 58.3±12.5 | 50.8±11.3 | 45.8±12.5 |
| Genetic and biochemical factors | 54.26±22.9 | 48.6±34.9 | 43.2±32.8 | 60.8±8.6 | 60.5±17.2 | 56.8±18.5 |
| Allergic and other environmental factors | 43.23±24.4 | 39.4±29.8 | 40.3±26.7 | 50.0±15.16 | 47.6±16.4 | 45.3±15.9 |
| Nutritional and metabolic factors | 84.1±27.15 | 81.5±39.6 | 80.3±30.92 | 95.0±23.7 | 87.1±23.6 | 85.5±22.3 |
| Structural factors | 49.3±24.41 | 38.1±27.8 | 37.1±28.8 | 54.16±9.7 | 53.4±11.8 | 43.9±12.4 |

[1]All values are expressed as the mean ± SD and no. (%)
[2]Significantly different from males (two-sided unpaired Student's t-test), $p<0.05$. * $p<0.05$; ** $p<0.01$

**Table 6. Mean intake of nutrient and food groups at the age of overall in males and females[1]**

| Variables | Canadian recommendations for food groups[2] | Males (n=125) | | | Females (n=25) | | |
|---|---|---|---|---|---|---|---|
| | | Leisure-time physical activity | | | Leisure-time physical activity[3] | | |
| | | Low | Moderate | High | Low* | Moderate** | High** |
| Milk products, (servings/day) | 2–4 | 3.5±1.9 | 7.6±2.8 | 9.4±3.1 | 2.2±1.3 | 3.6±4.2 | 5.4±2.8 |
| Grain products, (servings/day) | 5–12 | 6.7±3.2 | 8.6±3.6 | 10.7±4.6 | 5.7±2.5 | 6.2±4.1 | 7.2±3.6 |
| Meat and alternatives, (servings/day) | 2–3 | 2.6±1.6 | 4.7±2.3 | 5.1±2.9 | 1.9±1.2 | 2.9±1.7 | 3.9±3.2 |
| Fat and oils, (servings/day) | N/A | 5.2±5.3 | 6.3±4.9 | 7.2±4.1 | 4.2±3.6 | 5.3±2.5 | 6.1±3.4 |
| Vegetables and fruit, (servings/day) | 5–10 | 4.5±3.3 | 4.5±3.3 | 4.5±3.3 | 3.5±2.0 | 3.9±3.7 | 4.1±2.5 |
| Sweets and desserts, (servings/day) | N/A | 3.4±2.7 | 5.7±3.2 | 6.1±3.6 | 2.9±1.7 | 3.2±1.7 | 4.9±1.8 |
| Calcium, (mg/d) | 1300 | 958±423 | 1558±645 | 1730±365 | 920±345 | 1150±450 | 1320±365 |

[1]All values are mean ± SD
[2]The intake in the participants was compared with the lower value in the range
[3]Significantly different from males (n=125) (two-sided unpaired Student's t test): *$p<0.05$. **$p<0.001$

high amount of sweets and desserts. Calcium intake increased in both genders compared with the lower value in the range. The greater magnitude of this increase in males was related to their greater body size. For participants with moderate to high LTPAS, a dramatic increase was observed in calcium intake in males, whereas calcium intake decreased in females. Males had significantly higher intakes of calcium than females ($p<0.05$; Table 2). The link between calcium intake and PA in the moderate to high statuses in particular elicited beneficial interrelations, and low calcium intake may affect bone health.

Table 7 shows a correlation matrix for dependent and independent variables. The results demonstrated a positive signifi-

**Table 7. Correlation matrix between lifestyle factors, body mass index, calcium consumption, and physical activity of males and females[1]**

| | Males (n=125) | | | Females (n=25)[2] | | |
|---|---|---|---|---|---|---|
| | Leisure-time physical activity | | | Leisure-time physical activity[3] | | |
| **Variables** | **Low** | **Moderate** | **High** | **Low** | **Moderate** | **High** |
| Age, (years) | 0.56* | 0.61* | 0.60* | 0.38** | 0.43** | 0.73** |
| Body weight, (kg) | 0.71* | 0.62* | 0.54* | 0.67** | 0.74** | 0.55** |
| BMI, (kg/m$^2$) | 0.64** | 0.51** | 0.54** | 0.74** | 0.68** | 0.56** |
| Total lifestyle score | -0.59** | 0.44** | 0.62** | -0.52** | 0.48** | 0.60** |
| Calcium consumption, (mg/day) | -0.14** | 0.12** | 0.10** | -0.17** | 0.18** | 0.15** |

BMI: body mass index
[1]Data presented as coefficient (R);
[2]Significantly different from boys (n=125), (2-sided unpaired Student's t-test), *p<0.05; **p<0.001
[3]The intake in the subjects was compared with the lower value in the range

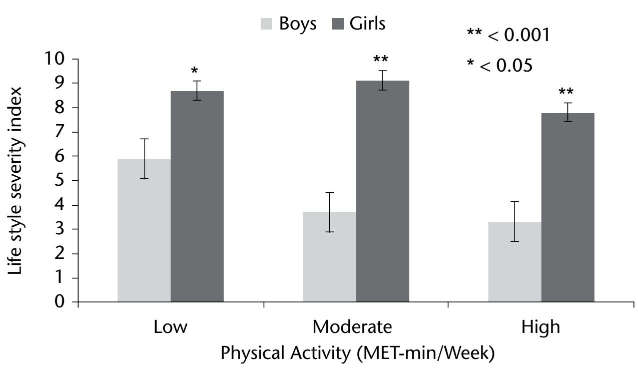


Figure 1. Mean (±SEM) lifestyle severity index based on physical activity (MET-min/week) in males (n=125) and females (n=25). Lifestyle severity index differed significantly between males and females in all physical activity levels, *p<0.05, ** p<0.001

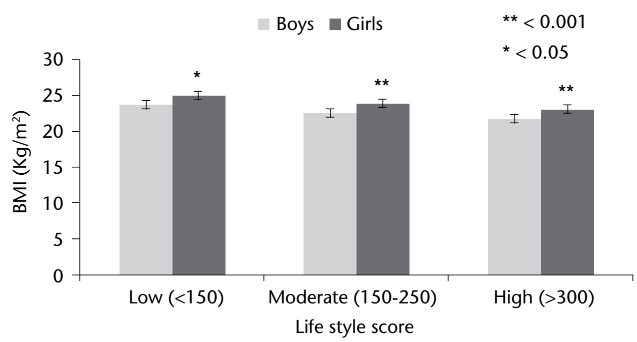


Figure 2. Mean (±SEM) body mass index based on lifestyle factors score in males (n=125) and females (n=25). The BMI differed significantly between males and females among the lifestyle factor scores, *p<0.05,** p<0.001

cant correlation between LTPAS and body weight gain, BMI, and age. In contrast, total life stress score and calcium intake were negatively correlated (p<0.01) in both genders with low LTPAS rather than moderate and high LTPAS. Thus, low calcium intake and higher life stress factors may play a role in PinA.

Figure 1 shows the results of the influence of the stress severity index of lifestyle stress on PA among participants. All PA intensities were directly affected by lifestyle stress parameters. The severity of lifestyle significantly affected PA in females with low (p=0.05), moderate (p=0.001), and high (p=0.001) LTPAS compared with the relative measures in males. The findings of this study suggest that lifestyle PA affects PA. BMI increased significantly (p=0.05) in females with high lifestyle stress than males (Figure 2).

## Discussion

The importance of PA, particularly LTPA, in decreasing the risk for non-communicable diseases such as coronary heart disease and metabolic syndrome is well-known (40). The identification of the reliable predictors of the various components of LTPA will enable healthcare providers to intervene and change the patterns of LTPA in the population and thereby improve community health (41).

Observations from this study suggest that there is an effect of lifestyle and diet on PA patterns among young Saudis aged from 15 to 22 years. The reliability of stress questionnaires was also evaluated to investigate the importance of lifestyle in PA using the test–retest reliability method. The results showed that the questionnaire was reliable, with better results for investigating lifestyle among the studied participants.

We reported that there is a moderately high prevalence of PinA (including all domains) in Saudis (38%). However, we also showed that highly active participants represented 62% of our total sample in this study, whereby a greater number of these participants were males (60.0% vs. 2.0% of females). We also found that PinA ranged from 43.3% to 99.5% in KSA, which was higher than PinA reported in many European and North American countries (42,43). We suggest that lifestyle and associated cultural contexts are an important cause of a high prevalence in PinA. Moreover, changes in economic status may be influential in lifestyle behaviors leading to PinA. For example, changes in work behaviors combined with modern conveniences associated with life-style easing technology may attenuate PA and related muscle mass. We reported that work-related activity was a major contributor to PA, which is consistent with findings in other studies (43).

We observed that participants with low PA showed higher lifestyle stress influence than those with moderate and high LTPAS levels. However, we also showed that gender influences these relationships, with females at all LTPAS levels showing significantly higher total life stress influence than males. Additionally, nutritional and metabolic factors followed by genetic, biochemical, and emotional factors comprised the most effective parameters for the status of LTPAS levels among participants. Furthermore, the increase in lifestyle severity score was significantly ($p<0.01$) correlated with the type of PA performed by males and females. The data showed positive significant correlations with moderate and high LTPA and a negative correlation with low LTPA. These findings indicate the negative effects of lifestyle on PA among young adult Saudis.

The majority of the Saudi population is generally shifting toward a more sedentary lifestyle, wherein people are moving away from PA-related work such as agriculture. In Saudi Arabia, only 6.7% of the population is currently involved in agriculture-related work (44). Another factor potentially contributing to high PinA is the subsidized oil price in the country coupled with a poor public transport system. This results in an increased use of motorized vehicles for commuting even for short distances. In Saudi Arabia, the number of cars/1000 people has increased from 93 to 336 in the last 10 years (45). Therefore, transport-related PA is not expected to rise in Saudi Arabia in the near future. Thus, LTPA must increase to meet the standard PA recommendations for a healthy lifestyle.

Consistent with previous studies conducted in Saudi Arabia, the present study indicated a low level of LTPA among adult Saudis, which are lower than other developing/transitional or developed countries. For example, PA and LTPA data for adults in developing countries such as Brazil (46) and Albania (47) are low, ranging from 53% to 97%. In developed countries such as the USA (48), Sweden (49), and Germany (50), the prevalence of LTPA inactivity was lower, ranging from 21% to 61.5%. Accordingly, the American Heart Association recently adapted their recommendations to combine the duration, frequency, and intensity of activity, and they now recommend that "all healthy adults aged 18–65 years need moderate-intensity aerobic PA for a minimum of 30 min for 5 days each week or vigorous-intensity aerobic activity for a minimum of 20 minutes for 3 days each week " (51). Thus, using the previous cutoff, nearly 80.0% of the Saudi adults in the present study did not meet the AHA criteria for activity standards.

In addition to economy, age and gender are important factors determining variation in LTPA. In this study, nearly 36.0% of women and 8.0% of men were in the low LTPA category, and women were less active than men, which is similar to results reported in a previous population-based study conducted in Saudi Arabia (32). The present findings are consistent with most literature from both developed countries such as the United States (40) and developing countries such as those in the Baltic states (52), which showed that women are less active in terms of LTPA than men.

We show that PA is closely interrelated with energy intake. The working body requires energy and nutrients to fuel activity and function. When prolonged, strenuous PA is performed on a regular basis, it causes an increase in the overall energy turnover (53). Many nutrients and food components that are consumed as part of a westernized diet potentially have a positive or negative impact on bone health as a measure of PA. Therefore, reaching a clear understanding of the relationship between PA and food intake may prove valuable for choosing the most beneficial approach for individual and societal health management.

This study shows that in moderate to high PA domains, the mean intake of all food groups in males was higher than females. Most participants did not eat sufficient fruits and vegetables, whereas sweets and desserts were overconsumed. These findings are similar to those of other studies, which reported that high PA is required for an increase in food intake (54). For example, vigorous PA on a daily basis not only increases the overall intake of energy (55) but also the intake of other constituents of food such as micronutrients. Therefore, in conjunction with low-energy food that has an abundance of minerals and vitamins, PA is likely to not only enhance human health in general (53) but also prevent micronutrient deficiencies (43,54).

In highly physically trained persons, enormous daily energy expenditure due to vigorous exercise is generally matched by a high-energy intake (56). In contrast, under normal conditions, increased energy expenditure due to short-term PA is not automatically compensated for by changes in energy intake in both lean and obese individuals (57).

Dietary factors ranging from inorganic minerals (e.g., calcium, magnesium, phosphorus, sodium, potassium, and various trace elements) and vitamins (vitamins A, D, E, K, C, and certain B vitamins) to macronutrients such as proteins and fatty acids may also affect bone health and thus increase the risk of osteoporosis (58). In this study, a marked gender difference was observed for food choices, and the high intake of calcium or milk products by males increased in almost all LTPA groups compared with females. The increased calcium intake was significantly correlated with the intensity of PA. The participants with moderate and high LTPA showed a positive significant correlation, whereas those with low LTPAS in calcium intake showed a negative correlation.

The current hypothesis was that calcium intake modifies the bone response to PA. PA also has beneficial effects on BMD where calcium intake is high, whereas the mean calcium intakes of <1000 mg/day have no effect (59). Calcium intake was previously reported as a significant predictor of BMD in males (60); thus, the current findings suggest that calcium intake from other sources is important.

The intake of vegetables and fruits in this study had a significant independent effect on BMD development in males and females. Fruits and vegetables provide organic salts of potassium and magnesium that have a buffering effect. Another component found in vegetables is vitamin K, which is an essential cofactor for osteoblastic activity (61). Natural antioxidants and phytoestrogen compounds in some vegetables may also have bone-protective effects (62). We showed that vegetables and fruits were significant predictors of BMD in males aged 8–20 years. Overall, this study supports the concept of a beneficial lifetime effect on bone health from the intake of vegetables and fruits.

Public officials have long known that an increased level of exercise is negatively related with body fat or weight. Numerous empirical studies have confirmed such a relationship (63). The relationship between PA and body fat or weight is derived from the assumption that a normal-weight person's energy intake is equal or nearly equal to his/her energy expenditure (64). In this study, the BMI index was negatively correlated with the level of PA and positively correlated with the score for lifestyle stress factors, particularly in relation to food intake. Females had significantly higher BMIs (p<0.01) than males in all stages of PA; however, a higher ratio was obtained in the participants of low PA with a higher lifestyle stress score. These data showed that lifestyle, diet, and BMI play important roles in PA, particularly in a population with a sedentary lifestyle.

PA is not the only factor that affects BMI. A host of factors, including occupational activity, stress, smoking, socioeconomic status, drinking, diet (1,6,7,26,65), being in school, seasonal variations, physical fitness, personal health, and genetics also apparently impact a person's weight (66,67).

## Conclusion

We showed that low LTPA levels and intensity were generally observed among adult Saudis. We observed that a large part of PA in both genders came from work-related activity. Nearly 38% of the sampled population did not achieve the recommended LTPA level for beneficial health effects. Highly active participants were mostly males and represented 62% of the total sampled population. Female gender, BMI, lifestyle, calcium intake, and diet were correlated with low LTPA. Saudi adults are recommended to improve their lifestyle by, for example, consuming more calcium and vitamin D. PA is also essential for achieving optimal bone mass and reducing the rate of bone loss.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the local ethics committee of Rehabilitation Research Chair (RRC), King Saud University, Riyadh, Saudi Arabia.

**Informed Consent:** Written and verbal informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

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