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PHYSICAL ACTIVITY AND SLEEP QUALITY AMONG HEALTHY ADULTS IN JEDDAH, SAUDI ARABIA: A CROSS-SECTIONAL STUDY

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Abstract
Physical activity (PA) and good sleep quality are crucial components of individual health and well-being. We aimed to evaluate PA and sleep quality among adults living in Jeddah, Saudi Arabia. As well as, to analyze the factors associated with PA and sleep quality among this population. We conducted a cross-sectional questionnaire-based study. We used two validated questionnaires: the International Physical Activity Questionnaire-Short Form (IPAQ), and the Pittsburgh Sleep Quality Index (PSQI). This study included 455 individuals, 298 (65.5%) were females, 314 (69%) were non-Saudi, and 215 (47.3%) were in the age group between 18-30 years. 41.3% of the participants had low PA, 24.8% had moderate PA, and 33.8% had high PA. Poor sleep quality was reported by 62.9 % of the participants. Physical inactivity was significantly associated with high age group (51 - 60 years) (OR: 2.58, 95% C.I.: 1.16 − 5.74, p = 0.02), female gender (OR: 3.08, 95% C.I.: 1.94 − 4.9, p <0.0001), ever married status (OR: 1.89, 95% C.I.: 1.89 − 3.07 p = 0.01), overweight or obesity (OR: 1.82, 95% C.I.: 1.17 − 2.78, p = 0.007), and smoking (OR: 1.71, 95% C.I.: 1.05 − 2.78, p = 0.031). Poor sleep quality was strongly associated with both physical inactivity (OR: 2.29, 95% C.I.: 1.51 − 3.47, P= 0.0001) and being overweight or obese (OR: 2.1, 95% C.I.: 1.41− 3.13, p = 0.0003). A high frequency of physical inactive and poor sleep quality was reported among adults living in Jeddah, Saudi Arabia. A significant association was found between physical inactivity and poor sleep quality. Given the high prevalence of poor sleep quality in this population, public health interventions promoting regular physical activity, particularly among high-risk groups, are essential to improving sleep quality and overall health outcomes.

Keywords: Physical activity, Sleep quality, International Physical Activity Questionnaire-Short Form (IPAQ), Pittsburgh Sleep Quality Index (PSQI), Saudi Arabia, Public health

1. Introduction:
Performing physical activity (PA) on regular basis has multiple health, social and economic benefits. In the year 2018, the World Health Assembly (WHA) endorsed the *Global Action Plan on Physical Activity (GAPPA) 2018–2030,* [1] aiming to decrease the global physical inactivity among adults and adolescents by about 15% by 2030. As part of the WHA Resolution (WHA71.6), Member States requested that WHO update the 2010 Global Recommendations on Physical Activity for Health. The latest global estimates indicate that 27.5% of adults and 81% of adolescents fail to meet the aerobic exercise recommendations set out in the 2010 Global Recommendations on

Physical Activity for Health [2]. Adopting unhealthy lifestyle such as physical inactivity, sedentary life, unhealthy eating habits and poor sleep quality are associated with many adverse health consequences, like obesity, cardiovascular, respiratory, and musculoskeletal diseases, as well as metabolic disorders as insulin resistance and type 2 diabetes mellitus. It is also associated with defective cognitive function and negative psychological wellbeing [1,3-5]. The prevalence of physical inactivity within Saudi Arabia has been estimated to range between 26% and 85% among Saudi males and between 43% and 91% among Saudi females [6].

Sleep is a crucial physiological process that plays key role in human wellbeing and normal body functions. Healthy sleep habits are also important for cognitive functioning, mood, mental health, cardiovascular, cerebrovascular, and metabolic wellbeing [7]. Inadequate sleep duration or poor sleep quality may lead to several physical, psychological, and metabolic disorders such as diabetes, increased risk of cardiovascular diseases, depression, and increased risk of suicide [8,9]. Sleep quality is determined by sleep duration, the delay in falling asleep and by the type and amount of sleep throughout the duration of sleep [10]. The recommended duration of sleep for healthy adults is between 7-8 hours per night to feel rested with optimal sleep quality [8]. Worldwide, the prevalence of sleep disorders is 27.3%. In Saudi Arabia, one study suggested that 61.6% of the Saudi population either have or may have sleep disorders [11,12]. Compared to other countries, adolescents in Saudi Arabia showed a higher percentage of poor sleep quality, they had a larger delay in weekend sleep and rise times [13].

Regular exercise has been found to increase both sleep quality and duration. However, there is still a debate in the literature about which types of PA are best for improving sleep [14]. It is unclear how PA affects the quality of sleep and needs to identify the relation between PA and sleep quality. This study aimed to evaluate physical activity and sleep quality among healthy adults in Jeddah, Saudi Arabia. Additionally, it sought to investigate the impact of various sociodemographic factors on physical activity and sleep quality, as well as the relationship between these two variables within the study population.

2. Materials and methods:

2.1. Study design:

This was a cross-sectional study that was conducted in Jeddah, Saudi Arabia in the period between November 2023 till May 2024.

2.2. Study subjects:

We included residents in Jeddah city whose age ranges between 18 to 60 years old who accepted to participate in this study.

2.3. Exclusion criteria:

We excluded individuals who have any chronic disease that interferes with their ability to do physical exercise e.g. rheumatologic diseases and neurologic diseases, and those who have any psychiatric illness. Also, we excluded individuals who gave incomplete responses.

2.4. Sampling technique:

We used a convenient non-probability sampling technique.

2.5. Sample size calculation:

The sample size was calculated using the Epi Info StatCalc softwear version 7. The expected size of our target population was around 3 million, considering the proportions of questionnaire accuracy as 50% and a margin of error of 5%, with a confidence interval of 95%, which gave 385 participants, as the minimum sample size.

2.6. Data collection method:

A structured questionnaire was used to assess the level of PA and sleep quality among the participants. It was constructed using Google forms and was distributed through social media channels to residents in Jeddah.

The questionnaire consisted of three sections:

The first section collected sociodemographic data such as age, gender, nationality, marital status, education level, employment status, and monthly income. Self-reported weight and height were used to calculate the Body mass index (BMI). BMI was determined by dividing weight in kilograms (Kg) by the square of height in meters (kg/m^2). BMI was divided into four groups according to the WHO criteria: underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25–29.9 kg/m^2), and obese (BMI ≥ 30 kg/m^2 or more)" [15]. The second section assessed PA level using the short version of the International Physical Activity Questionnaire (IPAQ) [16]. The third section consisted of the Pittsburgh Sleep Quality Index (PSQI) [17]. The IPAQ and the PSQI were previously validated and translated to Arabic language.

2.7. Statistical analysis:

Data were collected and coded by using Microsoft Excel. Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS), Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were carried out for all variables. Categorical variables were presented as frequency and percentages. Numerical variables were presented as mean and standard deviation (SD). The associations between categorical variables were tested using Chi square or Fisher's exact test (if > 20% of expected values were < 5). Binary logistic regression analysis was used to evaluate factors associated with low PA and poor sleep quality. A p-value < 0.05 will be considered significant.

2.8. Ethical approval:

This research was carried out in line with the Helsinki Declaration. Ethical approval was obtained from the Ethical Committee of Ibn Sina National College for Medical Studies (IRRB Ref No.: IRRB-ER/01-13052024). Ethics and confidentiality of data were assured. All participants were asked about their consent before responding to the questionnaire. Participation in this research was completely voluntary and anonymous.

3. Results:

This study included 455 healthy individuals who lives in Jeddah, Saudi Arabia. They were 298 (65.5%) females and 157 (34.5%) males, their age ranged between 18 to 60 years (mean age 33.67 ± 10.96 years). The majority were Saudi representing 69.0% (314/455), 51.9% (236/455) were married and 58.9% had a Batchelor degree or higher (268/455). More than two-thirds were employed (65.3%) and 40.2% had a monthly income of 5000-14999 SR. Most of the participants were non-smokers (76.3%). More than half (58.7%) of the participants were overweight (38.7%) or obese (20.0%). Table 1 shows the sociodemographic characteristics of the participants.

Table 1: Sociodemographic characteristics of the participants.

		Frequency (n=455)	Percent (%)
Age groups (years)	18-30	215	47.3
	31-40	114	25.1
	41-50	85	18.7
	51-60	41	9.0
Gender	Female	298	65.5
	Male	157	34.5

Nationality	Saudi	314	69.0
	Non-Saudi	141	31.0
Marital status	Single	160	35.2
	Married	236	51.9
	Divorced/widow	59	13.0
Education	Primary or uneducated	14	3.1
	Secondary school	49	10.8
	High school	124	27.3
	Bachelor's degree or higher	268	58.9
Employment	Unemployed	153	34.7
	Employed	297	65.3
Income (SR)	< 5000	179	39.3
	5000-14999	183	40.2
	>15000	93	20.4
Smoking	No	347	76.3
	Yes	108	23.7
Body mass index (BMI) (Kg/m^2)	Normal BMI	188	41.3
	Overweight	176	38.7
	Obese	91	20.0

In this study, 41.3% of the participants had low PA level, 24.8% had moderate PA, and 33.8% had high PA. We further classified the participants into physically inactive (low PA) and physically active (moderate and high PA). More than around two-thirds (62.9) of the participants had poor sleep quality (Figure 1).

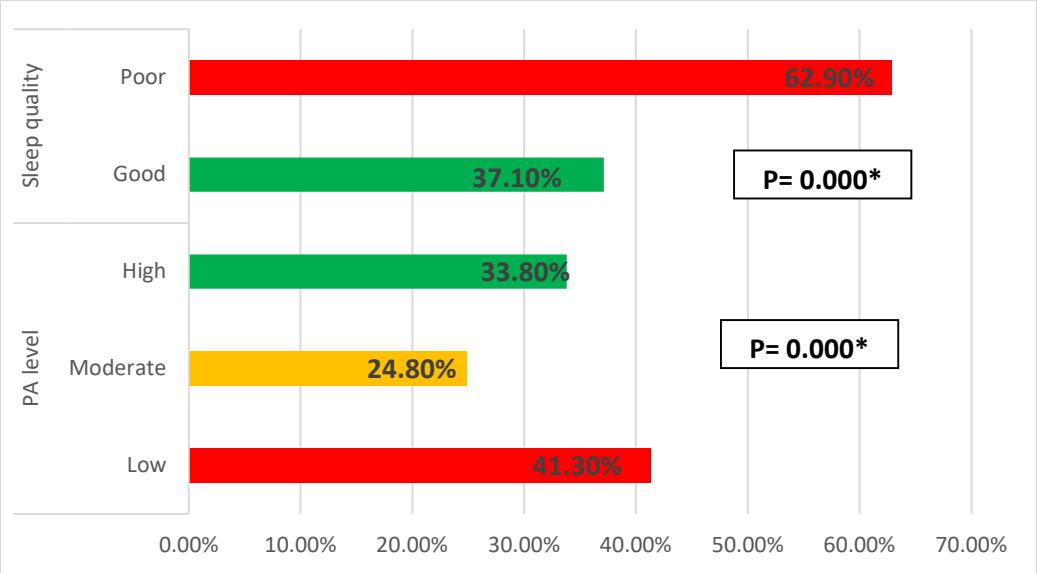

Figure 1. Shows physical activity (PA) level and sleep quality among the participants.

Table 2 shows the comparison between physically inactive and physically active groups as regards the sociodemographic factors. Physically active individuals were significantly younger than inactive individuals (p=0.02). There was a significant predominance of female gender (77.8%) and ever married (married, divorced or widow) individuals (74.6%) among the physically inactive group (p<0.0001, p=0.038 respectively). Smoking status showed a significant association with PA

levels (P=0.034), non-smokers were more prevalent in the high activity group (79.7%). BMI categories showed a highly significant difference across PA levels (P<0.0001). Among physically inactive group 68.8% were overweight or obese, compared to 51.5% among the physically active group, this difference was statistically highly significant (p<0.0002). In the current study, there was no significant difference between physically active and inactive group regarding nationality, education level and income (p>0.05).

Table 2: Association between physical activity levels and sociodemographic characteristics of the participants.

Participants' characteristics		Moderate or high physical activity (Active) (n=266)	Low physical activity (Inactive) (n=189)	X^2	P-value
		Number (%)	Number (%)		
Age groups (years)	18-30	130 (48.9)	85 (45)	11.0	0.012
	31-40	70 (26.3)	44 (23.3)		
	41-50	52 (19.5)	33 (17.5)		
	51-60	14 (5.3)	27 (14.3)		
Gender	Male	116 (43.6)	41 (21.7)	23.48	<0.0001*
	Female	150 (56.4)	148 (78.3)		
Nationality	Saudi	179 (67.3)	135 (71.4)	0.88	0.35
	Non-Saudi	87 (32.7)	54 (28.6)		
Marital status	Never married	112 (42.1)	48 (25.4)	13.53	0.0002*
	Ever married	154 (57.9)	141 (74.6)		
Education	Primary school or uneducated	8 (3.0)	6 (3.2)	1.65	0.648
	Secondary school	32 (12.0)	17 (9.0)		
	High school	68 (25.6)	56 (29.6)		
	Bachelor's degree or higher	158 (59.4)	110 (58.2)		
Employment	Unemployed	82 (30.8)	76 (40.2)	4.29	0.038*
	Employed	184 (69.2)	113 (59.8)		
Income (SR)	< 5000	98 (36.8)	81 (42.9)	5.54	0.063
	5000-14999	119 (44.7)	64 (33.9)		
	>15000	49 (18.4)	44 (23.2)		
Smoking	No	213 (80.1)	134 (70.9)	5.14	0.023*
	Yes	53 (19.9)	55 (29.1)		
BMI (Kg/m^2)	Normal weight	130 (48.9)	58 (30.7)	15.1	0.0001*
	Overweight or obese	136 (51.1)	131 (69.3)		

Chi-square test, * significant p-value (p < 0.05).

Binary logistic regression analysis was used to analyze the determinants of physical inactivity. The model was based on multiple variables including the demographic characteristics, smoking status,

and BMI. Within the model, female gender (OR: 3.08 (95% CI; 1.345 – 3.170, p <0.0001), individuals within the age group between 51 and 60 years (OR: 2.58, 95% CI; 1.16 - 5.76, p = 0.02), ever married individuals (OR: 1.89, 95% CI; 1.17 - 3.07, p = 0.01), smokers (OR: 1.71, 95% CI; 1.05 - 2.78, p = 0.031), and overweight or obese individuals (OR: 1.82, 95% CI; 1.17 - 2.81, p = 0.01) were the significant predictors of physical inactivity (Table 3).

Table (3): Binary logistic regression analysis to assess factors associated with low physical activity (inactivity) among the participants.

		B	OR (95% CI)	P-value
Gender	Males		Reference	
	Females	1.049	3.08 (1.94 - 4.91)	0.0001*
Age (years)	18 - 30		Reference	
	31 - 40	-0.126	0.51 (0.51 - 1.52)	0.649
	41 - 50	-0.34	0.71 (0.39 - 1.31)	0.275
	51 - 60	0.95	2.576 (1.16 - 5.74)	0.02*
Marital status	Never married		Reference	
	Ever married	0.637	1.89 (1.17 - 3.07)	0.01*
Employment	Unemployed		Reference	
	Employed	0.45	1.57 (0.98 - 2.51)	0.06
Smoking	No		Reference	
	Yes	0.535	1.71 (1.05 - 2.78)	0.031*
Body mass index (BMI)	Normal weight		Reference	
	Overweight or obese	-2.17	1.82 (1.17 - 2.78)	0.007*

* Significant p-value (p < 0.05).

Table 4 presents a comparison between sleep quality and sociodemographic factors of the participants. A higher proportion of individuals with poor sleep quality was overweight or obese (66.4%) compared to those with good sleep quality (45.6%), and this difference is highly significant (p<0.0001). Physical activity is also significantly associated with sleep quality (p < 0.0001), with inactive individuals were much more likely to experience poor sleep quality.

Table 4: Association between sleep quality and sociodemographic characteristics of the participants.

Participants' characteristics		**Sleep quality**		**X^2**	**p-value**
		Good (n=169)	**Poor (n=286)**		
		Number (%)	**Number (%)**		
Age groups (years)	18-30	87 (51.5)	128 (44.8)	5.38	0.146
	31-40	40 (23.7	74 (25.9)		
	41-50	33 (19.5)	52 (18.2)		
	51-60	9 (5.3)	32 (11.2)		
Gender	Male	66 (39.1)	91 (31.8)	2.46	0.12
	Female	103 (60.9)	195 (68.2)		
Nationality	Saudi	113 (66.9)	201 (70.3)	0.58	0.45
	Non-Saudi	56 (33.1)	85 (29.7)		

Marital status	Never married	60 (35.5)	100 (35.0)	0.013	0.91
	Ever married	109 (64.5)	186 (65.0)		
Education	Primary or uneducated	6 (3.6)	8 (2.8)	4.89	0.18
	Secondary school	25 (14.8)	24 (8.4)		
	High school	43 (25.4)	81 (28.3)		
	Bachelor or higher	95 (56.2)	173 (60.5)		
Employment	Unemployed	40 (23.7)	83 (29.0)	0.72	0.79
	Employed	129 (76.3)	203 (70.9)		
Income (SR)	< 5000	62 (36.7)	117 (40.9)	1.44	0.49
	5000-14999	74 (43.8)	109 (38.1)		
	>15000	33 (19.5)	60 (21.0)		
Smoking	No	137 (81.1)	210 (73.4)	3.42	0.06
	Yes	32 (18.9)	76 (26.6)		
BMI (Kg/m2)	Normal weight	92 (54.4)	96 (33.6)	19.09	< 0.0001*
	Overweight or obese	77 (45.6)	190 (66.4)		
Physical activity	Active	122 (72.2)	144 (50.3)	20.67	< 0.0001*
	Inactive	47 (27.8)	142 (49.7)		

Chi-square test, * significant p-value

Other factors such as age (p=0.146), gender (p=0.12), nationality (p=0.45), marital status (p=0.91), education (p=0.18), employment (p=0.79), income (p=0.49) and smoking (p=0.06) do not show significant associations with sleep quality in this sample. Multivariate regression analysis revealed that the significant predictors of poor sleep quality were overweight or obesity (OR: 2.1, 95% CI; 1. 41-3.13, p = 0.0003) and physical inactivity (OR: 2.29, 95% CI; 1.51-3.47, P= 0.0001).

Table 5: Binary logistic regression analysis to assess factors associated with poor sleep quality among the participants.

		B	OR (95% CI)	P-value
Body mass index (BMI)	Normal weight		Reference	
	Overweight or obese	0.741	2.098 (1. 41-3.13)	0.0003*
Physical activity	Physically active		Reference	
	Physically inactive	0.828	2.289 (1.51-3.47)	0.0001*

* Significant p-value

4. Discussion:

Physical activity has many health-related benefits. On the other hand, physical inactivity, is considered a major risk factor for the development of non-communicable diseases and increased overall mortality [3,5]. Saudi Arabia is rapidly developing an environment that promotes PA and reduces sedentary lifestyle behavior among its population [18]. Physical inactivity rates among adults vary significantly within and between countries, with some populations reporting rates as

high as 80% [6]. It was reported that countries with the highest rate of physical inactivity among adults is from the Eastern Mediterranean region, the Americas, the Western Pacific areas and Europe. However, the South-East Asia region has the lowest rates of physical inactivity [19].

In this study we found that 41.5% (26.8% among males and 49.3% among males) of the participants had low physical activity levels, 25% had moderate physical activity, and 33.4% had high physical activity. Previous studies reported higher rates of physical inactivity among Saudi population, Al-Zalabani et al. reported in a national population-based study that 66.6% (60.1% for men and 72.9% for women) of the overall population in Saudi Arabia were physically inactive [20]. A systematic review was conducted in 2018 to study PA among Saudi population found that the prevalence of physical inactivity ranged from 26% to 85% among Saudi males and from 43% to 91% among Saudi females [6]. Another systematic review, included 18 studies that were published between the year 2007 and 2017, found that the prevalence of PA among adolescents in Saudi Arabia ranged from 4% to 44.5% [21]. The differences in PA levels may be contributed to the difference in regions, age distribution, gender, the type of PA instrument used in each study, and the physical inactivity criteria. AlTamimi et al. studied PA level among young males (20-35 years) living in Riyadh city, they concluded that physical inactivity was reported among 24.9% of the participants. The lowest rate of physical inactivity was reported among young males from the Philippines (14.0%), while, the highest rate was among Saudi males (41.5%) [22]. A cross-sectional study conducted in Arar, Saudi Arabia studied PA among healthy female adolescents (13-14 years old), found that the majority (92.7%) were not meeting physical activity recommendations of 60 min of moderate to vigorous PA daily [23]. A recent population-based study found that the rates of physical inactivity were 82.6% among Saudis (71.7% of Saudi males and 91.1% of Saudi females) and 86.1% of non-Saudi counterpart residents (83.9% of non-Saudi males and 92.0% of non-Saudi females) [24]. Several socio-cultural factors might contribute to these low levels of PA. The hot climate in Saudi Arabia often discourages outdoor activities, and cultural norms may limit participation, particularly among women, in physical activities outside the home [25]. Additionally, the reliance on motorized transportation and the lack of pedestrian-friendly infrastructure further exacerbates low physical activity levels [26]. The significant higher percentage of low PA among females found in this study is comparable to other studies from Saudi Arabia [6,20,24,27]. This may be contributed to social and cultural factors, as well as to the nature of high temperature weather in Saudi Arabia.

There was a significant negative correlation between age of the participants and their PA scores. As individuals age, physical activity tends to decline. This may be attributed to physiological changes in various systems and organs due to the decline in cellular function [28]. In addition, comorbidities such as arthritis and diabetes have a strong link to aging and a declining PA level [29,30]. Among factors that determine low PA levels, we found that marital status, employment, BMI and sleep quality was associated with physical activity level. Married individuals were more likely to report low physical activity levels. Married individuals often have lower physical activity levels due to increased family responsibilities and time constraints. These responsibilities can limit opportunities for exercise, particularly when balancing work, household duties, and childcare. Some studies have shown that married individuals spend less time exercising and participating in moderate-to-vigorous PA compared to unmarried individuals. Additionally, lower level of PA is more prominent among married women than married men [31-33]. Our results showed that more than two third of the participants who had high PA were employed. This result is similar to previous study done by Al-Zalabani et al. who found that retired, and unemployed individuals are more likely to have sedentary life and be physically inactive compared to employed subjects [20]. Employment

may provide opportunities for physical activity, such as workplace wellness programs, or access to gym facilities. Moreover, individuals employed in manual labor jobs, such as construction, and firefighting, are more likely to have higher PA levels compared to those in office-based jobs, such as working in the education sector, banking and call centers [34]. The present study showed that 38.7% of the participants were overweight and 20.0% were obese. Obesity is strongly linked to low physical activity levels. This relationship is bidirectional: physical inactivity contributes to weight gain and obesity, and, conversely, obesity often results in reduced physical activity due to physical discomfort, mobility limitations, and psychosocial factors such as low self-esteem and body image concerns [35]. Our results revealed that obesity was significantly associated with a higher risk of low PA among the participants. This result was consistent with previous studies from Saudi Arabia [27,34,36].

The current study showed a relatively high prevalence of (62.9%) poor sleep quality among our participants. Recent studies from Saudi Arabia reported higher prevalence of poor sleep quality (67.3% and 75.7%) among residents in Saudi Arabia [37,38]. Obese participants were found to have twice the risk to have poor sleep quality. Poor sleep quality is frequently linked to unhealthy habits and lifestyle changes, such as reduced PA and the intake of high-calorie foods and drinks [39]. We found a significant association between low physical activity and poor sleep quality among our participants. PA has a positive effect on sleep quality, especially on its depth, latency, and performance [40]. PA plays a crucial role in the maintenance of good sleep quality. Enough moderate to high intensity exercise can improve the quality of sleep and prevent insomnia [41].

5. Conclusion:

The findings of this study reveal that a substantial portion of the residents in Jeddah (41.3%) had low PA levels (physically inactive), while more than half of the participants were physically active (moderate and high PA). Physical inactivity was strongly associated with several demographic and lifestyle factors, including being aged 51-60, female gender, ever married status, being overweight or obese, and smoking status. Additionally, a high percentage of the participants experienced poor sleep quality. Poor sleep quality was significantly associated with both physical inactivity and being overweight or obese.

These findings underscore the importance of promoting regular physical activity as a means of improving sleep quality, particularly among those at higher risk, such as older adults, females, individuals who are married, those with higher body mass index, and smokers. Public health initiatives targeting these groups could play a crucial role in enhancing both physical and mental well-being in Saudi Arabia.

This study explored the relationship between physical activity (PA) levels and sleep quality among residents the participants. However, we recommend to do further studies to explore the complex relationship between physical activity and sleep quality, contributing to a deeper understanding and more effective interventions.

6. Study limitations:

The study has some limitations. The first one is the research design being a cross-sectional study. Data collected in this study depends on self-reported information about PA and sleep quality which may be subjected to recall bias. The last limitation refers to the calculation method of the Body Mass Index (BMI, it was calculated using self-reported weight and height. These results cannot be generalized to the whole Kingdome as it represents residents in Jeddah city. We did not ask about dietary habits including caffeine intake which may affect sleep quality.

7. Acknowledgment:
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8. Conflict of interest:
Authors declare no conflict of interest.

9. Funding:
None

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