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Applying the Transtheoretical Model to Exercise Behavior and Sleep Quality in Taiwanese College Students

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Abstract

Purpose: The purpose of this study was to leverage the explanatory power of the Transtheoretical Model of behavior change (TTM) in an investigation of the exercise habits of Taiwanese college students, as well as in an exploration of the relationship between sleep quality and physical fitness levels. **Method:** 647 college students (282 women, 365 men, from northern Taiwan volunteered as test subjects. TTM stages were determined using a questionnaire. The quality of their sleep was evaluated using a version of the Pittsburgh Sleep Quality Index (PSQI) tailored to Chinese populations, and their levels of physical fitness were gauged using a battery of field-based health-related fitness tests administered by well-trained instructors. Data were analyzed using one-way ANOVA. **Results:** The results suggest the following: (1) In terms of the TTM stages of implementing healthy exercise behavior, at the time of the study, only 21.7% of students surveyed were at TTM stages of engaging in regular exercise (11.4% in action, 10.2% in maintenance) Students at more advanced TTM stages of implementing regular exercise performed better in the physical fitness tests than did those who were at earlier TTM stages, and obtained lower global PSQI scores, suggesting superior sleep quality. (2) Significant differences between stages were found for the overall set of TTM and for each physical fitness variable (3) In males, significant correlations were observed between several indicators of fitness (BMI, 1600-m run/walk test, 1-min curl-up test, standing long jump) and certain PSQI sub-scores; in females, such a correlation with indicators of sleep quality was only identified in a single fitness indicator (the 800-m run/ walk test). **Conclusion:** The results generally support the TTM stage can be used to accurately predict a student's physical fitness level. These findings provide a basis for future studies investigating strategies that are effective in promoting wellness in college students and exercise promotion programs. For example, based on the observation that most Taiwanese college students are engaged in early stages of adopting healthy exercise habits, it is recommended that physical education courses be added to college curricula to encourage students in early stages of change, and to promote physical fitness.

Keywords: Transtheoretical Model, sleep quality, physical fitness, Taiwan college students.

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臺灣地區大學生運動行為與睡眠品質相關性之探討──運用跨理論模式

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摘　要

目的：透過跨理論模式 (TTM) 研究臺灣地區大學生的運動行爲，探討睡眠質量和體適能之間的相關性。**方法**：以台灣北部某大學自願參與之 647 位大學生爲本研究對象 (女 282，男 365 人，年齡爲 21.06 ± 1.59 歲，平均身高=167.45 ± 8.14 公分，平均體重 59.87 ± 11.87 公斤) 。睡眠質量之測試爲使用中文版匹茲堡睡眠質量指數 (PSQI) 對受試者之睡眠質量進行評價。體適能檢測由通過國民體適能檢測講習之教師進行檢測工作。採用單因素變異數進行數據分析。**結果**：研究結果顯示：一、在運動行爲上五個階段分別爲：思考前期 (precontemplation) 占 4.8%；思考期 (contemplation) 占 15.1%；準備期 (preparation) 占 58.4%；行動期 (action) 占 11.4%，而在維持期 (maintenance) 則占 10.2%。二、隨著運動行爲階段的改變，體適能表現隨之增加，且 PSQI 的得分降低。三、每個運動行爲階段之間體適能表現與 PSQI 皆有顯著差異之存在。**結論**：結果普遍支持 TTM 的有效性來了解大學生運動行爲，爲往後的研究和運動推廣計劃提供相關訊息。

關鍵詞：跨理論模式、睡眠品質、體適能、臺灣大學生。

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1. Introduction

The recent years have seen growing importance placed on research investigating the contribution of regular exercise to general wellbeing, an effect that is well documented across all age groups (Woodcock, Franco, Orsini and Roberts, 2011; Warburton, Charlesworth, Ivey, Nettlefold and Bredin, 2010). Physical fitness can be defined as the ability to achieve certain performance standards for physical activity, and is an outcome of habitual physical activity or exercise (Tuero, De Paz, & Marquez, 2001).

Modern society places numerous social and professional demands on its citizens, causing many people to feel that they have insufficient time to meet all of them. A frequent coping strategy is to borrow from time normally spent asleep, resulting in the negative consequences associated with sleep deprivation (Strine & Chapman, 2005). Literature confirms that sleep patterns alter the core body temperature and ultimately sleep deprivation leads to an overall decrease in body temperature (Holmes et. al. 2002). This dilemma motivates constant ongoing research into whether and how it is possible to make time spent asleep more efficient in terms of mental and physical restoration. However, an increasing number of recent publications and empirical studies have critically reexamined the popular notion that exercise is good for sleep. Exercise training programs have been recommended as non-pharmacological treatments for sleep disturbances in healthy individuals, based largely on epidemiological studies that show a positive association between exercise and indicators of sleep quality (Lande & Gragnani, 2010; Quan et al., 2007; Sherrill, Kotchou, & Quan, 1998; Vuori, Urponen, Hasan, & Partinen, 1988; Youngstedt, 2006).

Regular exercise can improve physical fitness, promote psychological wellbeing, and enhance the quality of sleep (Brown, Buboltz, & Soper, 2006), but it is difficult to maintain. Although numerous studies discuss the relationship between sleep and exercise, there is a gap in the research conerning the motivation necessary to effectuate the kind of health behavior that leads to these positive outcomes. Similarly, much research remains to be conducted on the different levels of individual participation in exercise, and on whether the positive association between fitness levels and quality of sleep is attributable to physiological differences between exercisers and non-exercisers. According to recent findings, women experience higher-quality sleep than do men, as suggested by longer sleep times, shorter sleep-onset latency and higher sleep efficiency (Krishnan, V.; Collop, N. A., 2006). However, for those women who lead an unhealthy lifestyle, changing it into a healthier one after participating in a lifestyle change program or intervention seems to be at least as hard (Assaf, et al., 2003) or even harder than it is for men (Rejeski, et al., 2003). Even less is known about the psychosocial mechanisms and determinants of lifestyle change, and the role played by gender in the dynamics of such changes remains a topic in need of further investigation.

The transition from high school to university life is often characterized by a temporary alleviation of academic pressure, which may trigger changes in a student's lifestyle. Importantly, recent studies suggest that college students are motivated to change their sleep and exercise habits (Levesque, Stanek, Zuehike, & Ryan, 2004). Based on previous research, it was hypothesized that individuals with poor sleep quality would abstain from regular exercise (Fath, & Ward, 2011). Furthermore, sleep dysfunctions have been related to other health factors such as alcohol use and physical exercise. Such findings suggest that similar factors may be linked to the sleep and exercise habits of college students.

Contemporary psychosocial theories can be leveraged to provide significant insight into the exercise behavior of individuals (Gavin, McBrearty, Sēguin, 2006). One of the more promising of these theories is the Transtheoretical Model (TTM) of behavior change (Prochaska and DiClemente, 1983). The TTM assumes that individuals vary in their levels of motivation and in their readiness to change their behavior. The theory classifies these differences in terms of five unique stages of behavior change (pre-contemplation, contemplation, preparation, action and maintenance), and offers strategies hypothesized to effectuate behavior change (e.g. efficacy expectation, decisional balance, and processes of change). Furthermore, the TTM recognizes that relapse is a normal occurrence for those undergoing significant behavior change. Among the studies published on the TTM, studies on exercise are among the most frequent, surpassed only in prevalence by studies on tobacco use and its prevention. The exercise-related TTM literature has been previously reviewed (Adams & White, 2002; Marshall & Biddle, 2001), it that investigates the relationship between theories of exercise behavior change and sleep quality is uncommon, so it remains to be understood whether and how exercise interventions might have a bearing on sleep quality. Given the interest in exercise and the TTM, a comprehensive, systematic, practitioner-friendly review is warranted.

It was predicted that students would be motivated to modify their exercise behavior, but not their sleep habits. It should be noted, however, that there have been few attempts to establish a correlational relationship between TTM and sleep quality and varied physical fitness. Therefore, the purpose of this study can be stated as follows: (1) To understand the extent to which differences in sleep quality can be accounted for by physical fitness levels; (2) to understand the different phase of implementing healthy exercise behavior according to phase of exercise behavior change questionnaire, and to attain a better understanding of the relationships between the different stages of exercise, gender, level of physical fitness, and quality of sleep; (3) to examine college students' motivations to adopt healthier behavior patterns that might improve the quality of their sleep; and (4) to understand the correlation between sleep quality and physical fitness to the future creation of training courses designed to enhance students' physical fitness and sleep quality. It is hoped that the results of this study may serve as a reference for schools, coaches, or physical education teachers, to assist them in guiding students in the development of healthier lifestyles, and thus of better qualities of life.

2. Methodology

2.1 Selection of test subjects

A total of 1682 college students rom northern Taiwan volunteered were invited to participate in the study, and were administered a questionnaire and physical fitness tests. However, after those subjects with incomplete survey responses were removed from the study, the total of number of subjects was reduced to 647 people (282 women, 365 men, age = 21.06 ± 1.59 years, mean height = 167.45 ± 8.14 cm, mean weight = 59.87 ± 11.87 kg). The subjects came from a variety of socio-economic backgrounds, and none had physical abnormalities or known medical or orthopedic diseases. All subjects were assured of their anonymity before completing any phase of the study.

2.2 Evaluation metrics

(1) Stages of exercise behavior change questionnaire

Each subject's phases of exercise behavior change was assessed using a 5-item, dichotomous scale (yes/ no) related to regular exercise to assess current exercise habits and intentions. Regular exercise was defined as exercising three times per week for 30 minutes or longer per session. Individuals were categorized into one of five stages of exercise behavior change.

In applying the TTM to exercise, most studies have relied on a "stages of change" model specifically adapted to exercise behavior change. The stages of exercise behavior change are defined as pre-contemplation (individuals are inactive and do not intend to begin exercising within the next 6 months), contemplation (individuals are inactive and are considering initiating exercise within the next 6 months), preparation (individuals exercise on an irregular basis but intend to become more active within the next month), action (individuals have engaged in regular exercise for less than six months), and maintenance (individuals have engaged in regular exercise for six months or more).

(2) Sleep quality evaluation

Subjects were asked to fill out the Chinese version of the Pittsburgh Sleep Quality Index (PSQI) questionnaire in a quiet classroom (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI questionnaire is a standardized measure designed to evaluate sleep quality. It consists of 19 questions chosen to assess the severity and frequency of symptoms associated with major sleep disorders. The questions measure self-rated sleep habits along seven dimensions: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The score for each component ranges from 0 to 3, and the sum of these component scores yields a global PSQI score that ranges from 0 to 21. Higher global scores indicate poor sleep quality (P), and lower scores indicate good sleep quality. The PSQI was administered before the physical fitness test on the same day. The global

PSQI score has high internal consistency and reliability and correlates moderately to highly well with other scales of sleep quality and sleep problems (Carpenter, Andrykowski, 1998). The test–retest reliability of the Chinese language PSQI has been reported to be valid (Lai & Good, 2005). The internal consistency of the original scale has been measured to have a Cronbach's α of 0.83, and the robustness of the questionnaire to test–retest variations has been measured to have a correlation coefficient of $r = 0.85$ (at a significance level of $p = 0.05$) (Buysee, et al., 1989). In this study the internal consistency as measured by Cronbach's α was 0.726.

(3) Physical fitness evaluation

The physical fitness tests used in our study emphasize health-related components and include measures of cardiovascular endurance (which can be used to gauge aerobic capacity by means of a run/ walk test, over distances of 800 m for women or 1600 m for men), body composition (body fat content, assessed by BMI), muscular strength and endurance, assessed by a 1-minute curl-up test), and flexibility (range of motion assessed by a sit-and-reach test).

(4) Study Design

Data were collected through a paper-based survey administered on the first day of classes in the semester. Before beginning the survey, participants were asked to review an attached consent form. They were also informed that completing the survey meant that they understood their rights and agreed to participate in the study. The questionnaire consisted of questions intended to gauge the TTM stage of healthy exercise behavior of each respondent. Physical fitness was gauged using a battery of field-based health-related fitness tests conducted by well-trained instructors.

2.3 Data analysis

Date results were expressed as mean ± standard deviation. Independent (unpaired) t-tests were used to assess the significance of differences in sleep quality and physical fitness both within and between genders. One-way ANOVA was used to compare the differences in sleep quality and physical fitness across the different stages of exercise behavior. Pearson product-moment correlation coefficient was used to assess the relationship between the variables for physical fitness and the global PSQI index. Statistical significance was set at $p < .05$.

3. Results

3.1 Subject sleep quality characteristics

The average time taken to fall asleep was 14.70 ± 13.25 min for all subjects (14.83 ± 12.81 min and 14.53 ± 13.82 min for the male and female groups, respectively); the average sleep duration was 6.82 ± 1.52 h for all subjects (6.88 ± 1.5 h and 6.74 ± 1.54 h for male and female groups, respectively); the average time spent in bed was 7.35 ± 1.74 for all subjects (7.47 ± 1.65 h and 7.20 ± 1.85 h for the male and female groups, respectively).

3.2 The relationship between sleep quality and physical fitness performance

Table 1 illustrates the differences in average sleep quality between the male and female groups. Previous studies have recommended that a global PSQI threshold of >5 has a diagnostic sensitivity of 89.6% and specificity of 86.5% (kappa =0.75, $p<0.001$) for distinguishing between good and poor sleepers (Buysse, et al., 1989). Based on this threshold, we classified the subjects into two groups: those reporting good sleep quality (G), and those suffering from poor sleep quality (P).

The data in Table 1 illustrate that while males suffered significantly less from sleep disturbances than did females, the female group experienced significantly better sleep efficiency than did the male group. Furthermore, a comparison between grouping good male and female sleepers together on the one hand, and poor sleepers of both sexes on the other reveals that all PSQI sub-scores (except for use of sleeping medication) were significantly better in good sleepers than in poor ones. In addition, Table 1 shows that for both males and females, good versus poor sleep quality did not significantly differentiate physical fitness performance, whereas good versus poor sleep quality was manifested as significant differences in all items in the sleep quality evaluation.

Table 1. Comparison of sleep quality and physical fitness performance indicators across good vs. poor sleepers

	Male				Female			
	Total (N=365)	Good sleep quality (N=72)	Poor sleep quality (N=292)	t value	Total (N=282)	Good sleep quality (N=52)	Poor sleep quality (N=230)	t value
Physical fitness indicators								
BMI (kg/m^2)	21.99 ± 3.46*	21.55 ± 2.80	22.10 ± 3.60	-1.206	20.27 ± 2.80	19.91 ± 2.23	20.34 ± 2.92	-1.019
Sit-and-reach test (cm)	30.17 ± 9.88	30.68 ± 9.25	30.07 ± 10.03	.467	33.17 ± 9.71*	33.31 ± 8.90	33.14 ± 9.90	.113
Standing long jump (cm)	208.40 ± 27.78*	205.33 ± 26.67	209.15 ± 28.09	-1.044	144.48 ± 24.71	142.58 ± 26.93	144.91 ± 24.22	-.615
1-min curl-up test (number of times)	39.26 ± 10.08*	40.25 ± 10.45	39.03 ± 10.00	.918	30.72 ± 8.14	30.92 ± 8.59	30.68 ± 8.06	.195
800/1600m run/walk test (s)	523.88 ± 92.14	531.10 ± 75.45	521.58 ± 95.57	.786	312.79 ± 79.32	315.60 ± 90.30	312.16 ± 76.82	.282
Sleep quality indicators								
Global PSQI (score)	6.86 ± 2.58	3.26 ± 0.95*	7.75 ± 2.03	-18.252	6.67 ± 2.51	3.40 ± 0.82*	7.41 ± 2.14	-13.243
Sleep duration	0.43 ± 0.74	0.13 ± 0.37*	0.51 ± 0.79	-3.997	0.54 ± 0.81	0.19 ± 0.45*	0.62 ± 0.85	-3.508
Sleep disturbances	1.21 ± 0.55*	0.82 ± 0.45*	1.30 ± 0.54	-7.035	1.34 ± 0.55	0.94 ± 0.42*	1.43 ± 0.54	-6.085
Sleep onset latency	1.14 ± 0.75	0.64 ± 0.56*	1.27 ± 0.74	-6.803	1.19 ± 0.72	0.65 ± 0.48*	1.31 ± 0.72	-6.287
Daytime dysfunction	1.15 ± 0.75	0.64 ± 0.56*	1.27 ± 0.75	-6.729	1.27 ± 0.74	0.67 ± 0.59*	1.40 ± 0.72	-6.863
Sleep efficiency	1.70 ± 1.43	0.40 ± 0.96*	2.02 ± 1.35	-9.633	1.03 ± 1.34*	0.25 ± 0.74*	1.21 ± 1.38	-4.841
Sleep quality	1.18 ± 0.68	0.64 ± 0.54*	1.32 ± 0.64	-8.397	1.24 ± 0.68	0.69 ± 0.54*	1.37 ± 0.65	-6.953
Use of sleeping medication	0.04 ± 0.23	0.00 ± 0.00	0.05 ± 0.25	-1.740	0.06 ± 0.32	0.00 ± 0.00	0.07 ± 0.35	-1.529

$p < .025$

3.3 Relationship between phases of exercise behavior, physical fitness performance, and sleep quality evaluation

Table 2 displays the differences in physical fitness performance and sleep quality across the different stages of exercise behavior, separated between the male and female groups. Across all five indicators of physical fitness, females in more advanced phases of implementing healthy exercise behavior performed significantly better than did those in earlier phases, though this trend was more apparent in certain indicators (standing long jump, 800m run/ walk test) than in others (BMI, sit-and-reach test, 1min curl-up test), in which only females in the maintenance phase distinguished themselves from those in the other phases.

Previous research suggests that higher body mass indices are associated with greater dissatisfaction with weight and the likelihood of engaging in weight-loss behaviours (McCabe & Ricciardelli, 2003). On the other hand, rather than wanting to lose weight, many adolescent males want to increase their bulk in order to achieve a more muscular ideal body (McCabe & Ricciardelli, 2001, 2003). According to McCabe and Ricciardelli (2003), although between 17% and 30% of boys want to be slimmer, between 13% and 48% desire a larger body size. Cohn and Adler (1992) and Raudenbush and Zellner (1997) reported that the rates of wanting to lose versus gain weight were almost equal among boys. Some research also suggests that many young women favour a slim but more mesomorphic body build (Lenart, Goldberg, Bailey, & Dallal, 1995).

In addition, Table 2 shows that students of both genders at more advanced stages of implementing healthy exercise behavior had lower (and thus better) global PSQI scores, but this trend was not significant, although males in the action phase did have significantly lower PSQI scores than did those in the phases of pre-contemplation and contemplation. Males in the action phase scored significantly lower in the categories of sleep onset latency and sleep quality than did those in the phases of preparation and contemplation, respectively. Finally, males in the maintenance phase used sleeping medication significantly less than did those in the phases of preparation and action.

Table 2. Relationships between phases of exercise behavior, physical fitness performance, and sleep quality

Metric	Gender	Pre-contemplation (N=31)	Contemplation (N=98)	Preparation (N=378)	Action (N=73)	Maintenance (N=66)	F value
BMI (kg/m^2)	M	21.00 ± 2.56	22.35 ± 4.68	21.77 ± 3.43	22.60 ± 3.45	22.37 ± 2.88	1.039
	F	20.83 ± 4.50	20.22 ± 2.44	19.92 ± 2.28	21.21 ± 2.93	22.14 ± 5.05*	3.000
Sit-and-reach test (cm)	M	24.00 ± 12.12	28.77 ± 9.25	30.39 ± 9.70	30.67 ± 9.09	30.80 ± 11.15	1.128
	F	30.50 ± 8.52	32.00 ± 10.10	33.48 ± 9.41	32.77 ± 9.59	40.6 2± 10.81*	2.684
Standing long jump (cm)	M	196.00 ± 26.93	202.97 ± 32.32	207.55 ± 26.87	210.06 ± 26.12	215.62 ± 29.82	1.752
	F	130.46 ± 32.35	139.78 ± 24.69	146.85 ± 22.94*	148.46 ± 22.88	156.92 ± 23.59*	3.861
1-min curl-up test (number of times)	M	29.56 ± 13.44	37.90 ± 9.99	39.08 ± 9.82*	40.41 ± 9.56*	41.43 ± 10.38*	3.077
	F	27.45 ± 7.35	29.18 ± 8.06	30.71 ± 7.54	34.36 ±8.78*	38.23 ± 10.25*	5.709
800/1600m run/walk test (s)	M	531.33 ± 100.00	537.58 ± 106.97	532.43 ± 91.38	515.43 ± 83.59	484.38 ± 82.88*	3.217
	F	390.36 ± 123.09	317.85 ± 74.69*	305.28 ± 71.02*	299.32 ± 51.41*	269.62 ± 72.31*	7.427

Pre-contemplation=1 Contemplation=2 Preparation=3 Action=4 Maintenance=5
BMI: F: 5>3 Sit-and-reach test: F:5>1,2 Standing long jump: F:5,3>1 1-min curl-up test: M: 3,4,5>1 ; F:4,5>1; 5>2,3
800/1600m run/walk test: M: 5<3; F:2,3,4,5<1

Sleep quality indicators							
Global PSQI (score)	M	8.56 ± 2.07	7.71 ± 2.48	6.94 ± 2.49	6.04 ± 2.38*	6.53 ± 3.01	3.459
	F	7.14 ± 2.36	6.79 ± 2.66	6.63 ± 2.47	6.41 ± 2.67	6.15 ± 2.30	.432
Sleep duration	M	0.22 ± 0.67	0.71 ± 0.86	0.40 ± 0.72	0.33 ± 0.68	0.51 ± 0.80	1.768
	F	0.73 ± 0.99	0.49 ± 0.75	0.55 ± 0.81	0.36 ± 0.79	0.62 ± 0.77	.652
Sleep disturbances	M	1.56 ± 0.53	1.10 ± 0.60	1.22 ± 0.72	0.88 ± 0.76	1.00 ± 0.81	2.551
	F	1.36 ± 0.58	1.31 ± 0.61	1.32 ± 0.53	1.45 ± 0.51	1.38 ± 0.51	.342
Sleep onset latency	M	1.44 ± 0.53	1.16 ± 0.78	1.22 ± 0.72	0.88 ± 0.76*	1.00 ± 0.81	3.086
	F	1.36 ± 0.90	1.21 ± 0.75	1.13 ± 0.69	1.36 ± 0.79	1.23 ± 0.44	.958
Daytime dysfunction	M	1.67 ± 0.71	1.26 ± 0.82	1.15 ± 0.78	1.02 ± 0.64	1.09 ± 0.71	1.684
	F	1.23 ± 0.87	1.31 ± 0.70	1.28 ± 0.76	1.18 ± 0.73	1.15 ± 0.69	.231
Sleep efficiency	M	2.33 ± 1.32	2.06 ± 1.34	1.67 ± 1.44	1.71 ± 1.46	1.53 ± 1.42	1.162
	F	1.27 ± 1.39	1.10 ± 1.39	1.05 ± 1.34	0.73 ± 1.27	0.54 ± 0.97	.959
Sleep quality	M	1.33 ± 0.70	1.39 ± 0.56	1.21 ± 0.67	0.94 ± 0.67*	1.15 ± 0.66	2.650
	F	1.18 ± 0.59	1.28 ± 0.74	1.23 ± 0.66	1.32 ± 0.78	1.23 ± 0.83	.186
Use of sleeping medication	M	0.00 ± 0.00	0.03 ± 0.18	0.02 ± 0.15	0.02 ± 0.14	0.15 ± 0.46*	3.861
	F	0.00 ± 0.00	0.07 ± 0.40	0.08 ± 0.33	0.00 ± 0.00	0.00 ± 0.00	.649

Pre-contemplation=1 Contemplation=2 Preparation=3 Action=4 Maintenance=5
Global PSQI: M: 4<1, 2 Sleep onset latency: M: 4<3 Sleep quality: M: 4<2 Use of sleeping medication: M: 5>3, 4
$p < .05$

3.4 Correlations between sleep quality and physical fitness performance

To assess the relationships between each pair of indicators, a correlational analysis was conducted, the results of which are summarized in Table 3.

Table 3. Correlation coefficients between indicators of sleep quality and of physical fitness for males and females

Sleep quality	**Gender**	**BMI**	**Sit-and-reach test**	**Standing long jump**	**1-min curl-up test**	**800/1600m run/walk test**
Global PSQI (score)	M	0.07	-0.049	-0.011	-.111*	-0.052
	F	-0.021	-0.026	-0.048	-0.033	0.013
Sleep duration	M	0.041	-0.007	-0.003	0.068	-0.093
	F	-0.044	-0.055	-0.02	-0.016	0.038
Sleep disturbances	M	0.031	-0.053	-0.059	-0.065	0.023
	F	0.066	-0.074	-0.096	-0.029	0.082
Sleep onset latency	M	-0.091	-0.086	-0.014	-0.034	0.097
	F	0.042	-0.028	-0.029	0	-0.05
Daytime dysfunction	M	0.048	-0.063	-0.015	-0.053	-0.034
	F	-0.05	-0.011	-0.042	-0.015	-.141*
Sleep efficiency	M	0.076	-0.011	0.029	-.129*	-.120*
	F	0.01	0.102	0.01	-0.042	0.024
Sleep quality	M	0.014	0.062	0.015	-0.046	0.032
	F	-0.043	-0.1	-0.02	0.012	0.104
Use of sleeping medication	M	.165**	0.006	-.111*	-0.08	0.07
	F	-0.099	-0.064	0.007	0.019	-0.015

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

$p < .025$

Some physical fitness tests were significantly correlated with global PSQI score. In males, scores for BMI, the 1600-m run/ walk test, the 1-min curl-up test, and the standing long jump were each significantly correlated with one of the various PSQI sub-scores; but in females, the only physical fitness indicator to correlate with a PSQI sub-score was the 800-m run/ walk test.

4. Discussion

To clarify about TTM stages of exercise behavior relationships between sleep quality and physical fitness performance in a young population, this study made an attempt to explore the association between sleep quality and physical fitness performance. The results of this study indicate that sleep problems are highly prevalent among college students (almost 81%): 522 out of 646 of our subjects reported a global PSQI index of greater than 5, indicating poor sleep quality. Across all the sub-scores of the PSQI questionnaire, the two most common problems reported in subjects with poor sleep quality in comparison to subjects with good sleep quality were too many sleep disturbances and inadequate sleep efficiency (Table 1).

Our study revealed that almost 15% of our subjects reported sleeping fewer than 6 hours per night. A previous survey-based study reported that the average sleep duration of college students was 7.75 h in 1969 and 6.75 h in 1989 and 6.65 h in 2001 (Robert, Cosette, & Robert, 2001). In our study, the average sleep duration was 6.82 ± 1.52 h for all subjects (6.88 ± 1.5 h and 6.74 ± 1.54 h for the male and female groups, respectively).

The only indicator of physical fitness that was found to significantly correlate to global PSQI index was the 1-min curl-up test for males. (Table 3). However, PSQI index was found to be significantly correlated with different phases of healthy exercise behavior, suggesting that regardless of the type of exercise engaged in by the subjects, a good exercise behavior profile promoted better sleep quality and decreased sleep problems.

The most important finding from these data suggests that college students are motivated to change their sleep and regular exercise behaviors. Based on previous research, individuals with poor sleep quality were hypothesized to abstain from regular exercise. However, in comparing various indicators of physical fitness between students with good sleep quality and those with poor sleep quality, it was found that, across both males and females, those with better sleep quality did not perform better on any of the physical fitness tests than did their peers suffering from poor sleep quality. The Transtheoretical Model suggests that for successful behavioral change to occur, interventions must be tailored to an individual's current stage of change and make use of the appropriate processes of change. Traditional interventions to increase physical activity have had some short term success but there has been minimal success in achievement of long term exercise adherence (Dishman, 1991). The temptations not to exercise are another viable avenue for interventions. Specifically for college students, it was found that the Competing Demands component is the most pronounced temptation for not exercising (Hausenblas et al., 2001). Interventions for this population have to determine where prevention of relapse can be targeted so that students can successfully maintain an exercise regimen.

Although results did not indicate a significant relationship between global sleep quality and indicators of physical fitness, individual indicators of fitness did correlate to certain individual indicators of sleep quality. This suggests a difference in the distributions of participants' motivations to change sleep and exercise behaviors. The findings of this study are generally consistent with previous research on this topic. Although most studies maintain a significant relationship between quality sleep and regular exercise (Brand, Gerber, Beck, Hatzinger, Puhse, & Holsboer-Trachsler, 2010), it seems these same associations cannot be assumed when examining an individual's process of changing these health behaviors.

However, the results of this study do support the notion that sleep deficiency is prevalent within populations of college freshmen. In concordance with suggestions made by Buboltz, Jenkins, Soper, Woller, Johnson, & Faes (2009), additional research concerning the sleep patterns of college students is recommended. In order to understand the process by which students are motivated to change these patterns, the behavior itself must be fully understood. Furthermore, it is important to note that some sleep behaviors are easier to change than others. Such as maintaining a consistent sleep-wake schedule and going to bed without being thirsty are relatively easy habits to change; reducing worry before falling asleep is more complicated and could require counseling or psychotherapy. Reducing environmental noise while one is trying to sleep can be particularly challenging-especially in university dormitories. Additional research is therefore warranted on how sleep quality can be improved by changing specific habits and behaviors. Such research could be underpinned by broader concepts of health-related behavior change, for example those related to regular exercise examined herein.

In addition, it is important to emphasize that methodological problems in the design of the study limit the scope of the implications that can be drawn from our findings. First, this study relied on subjective self-reports of sleep quality without objective verification. However, the prevalence of subjects with poor sleep quality in this age group and the global PSQI scores were comparable with values found in other studies. Second, the assessments of physical fitness were field-based and were not all conducted by the same instructor for the entire sample of subjects. Therefore, it is possible that this introduced systematic bias into the measurements of physical fitness. Future studies should take into consideration the limitations of this study.

5. Conclusion

In conclusion, the principal findings of this study can be summarized in three points. (1) Our study confirmed the high prevalence of poor sleep quality among young adults and failed to find any correlations between physical fitness and sleep quality. (2) This study found evidence to support the utility of the TTM in explaining exercise behavior in college students. Each stage of behavior change distinguished itself from the others in the physical fitness tests, in a manner consistent with what would be predicted by theory. It is understandable that the maintenance stage to perform better on physical fitness tests than those in any of the other stages of behavior change. (3) It is recommended that physical education courses that emphasize anaerobic exercise for men, and aerobic exercise for women, be added to the curricula of college students to increase their levels of motivation and to improve their physical fitness levels.

We can conclude with certainty that because of the adverse effects of unhealthy lifestyles on young adult's sleep quality and physical fitness, it is very important for the health education system to pay attention to these issues in college or high-school settings to prevent students from developing sleep disturbance patterns and inactive lifestyles.

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