Subjective and Objective Evaluation of Physical Activity Level and Its Relationship With Work Ability of Nurses In Different Hospital Departments

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Abstract

Background: *Due to the nature of shift work, nurses experience very high mental and physical pressure, which can ultimately affect their work ability (WA). One factor that affects work ability is the level of physical activity (PAL). Since nurses are responsible for providing healthcare for the public, it is necessary to evaluate their WA and PAL. Therefore, the present study used subjective and objective evaluation to test the relationship between PAL and WA among nurses in different hospital departments affiliated with Isfahan University of Medical Sciences.* **Methods:** *A descriptive-analytical study was conducted over 6 months. A questionnaire was used to measure the work ability index (WAI). The International Physical Activity Questionnaire (**IPAQ**) was used for subjective evaluation, and the Xiaomi smart wristband Mi Band Five was used for objective assessment. These tools extracted the components of behaviors related to physical activity for 7 days. One hundred nurses were selected for subjective evaluation, and then 40 of them were randomly selected for objective assessment. The SPSS software version 23 was used for data analysis. Multiple regression analysis was used to test the effect of physical activity on the work ability index by controlling other demographic variables.* **Results:** *7% of participants had poor WAI, and 45% had moderate work ability. Also, the ability to do good and excellent work was 32% and 16%, respectively. In this study, 31% of participants had low PAL, 42% moderate PAL, and 27% high PAL. In the objective evaluation, 12.5% of participants had a PAL of 100, 35% less than 100(poor), and 52.5% had a PAL above 100(High). In the subjective evaluation, the highest PAL belonged to the emergency department. The results of the subjective and objective methods to check the correlation between WAI and PAL showed a positive and significant correlation.* **Conclusion:** *In the present study, subjective and objective evaluations showed a significant relationship between work ability and PAL. The present findings can be used to develop future interventions to improve nurses' health and work performance.*

1. Introduction

In many countries, the labor force is aging [1, 2]. This challenge has driven governments to emphasize improving work ability and increasing working life [3]. Work ability is fundamental to well-being and health; thus, maintaining and enhancing it is crucial in ergonomics and occupational health. It reflects one's capacity to perform work efficiently based on health, needs, and cognitive abilities [4].

Research indicates that most job stress stems from a mismatch between abilities and job requirements. Studies have identified job stress as a key risk factor affecting work efficiency and capability. The work ability concept underlies workstation design and employee selection [6, 7]. The Finnish Occupational Health Institute's model effectively addresses the interplay between work-related, personal, and social factors and work ability. It asserts that work ability is influenced by individual capabilities (health and functional capacities), knowledge (skills and competencies), values, motivation, work-related factors (physical, mental, and social needs), and external factors (family, friends, and social bonds). Central to this model are physical and mental health. Additionally, the model identifies PAL as a factor affecting work ability [8].

Physical activity is key to health management worldwide [9]. It is crucial for preventing disorders like cardiovascular diseases, obesity, type 2 diabetes, osteoporosis, and back pain [10]. Increased mobile phone usage has led to more musculoskeletal disorders [11]. Continuous physical activity reduces cancer-related mortality by 25-30%, with men benefiting by 59% [12]. Health and Human Services recommend 150 minutes of moderate-intensity aerobics weekly [13].

Nursing is central to healthcare, exposing individuals to high mental and physical stress from shift work [14]. This can lead to sleep disorders, psychological issues, and heart and digestive problems, affecting work ability [15]. Assessing nurses' work ability is essential, as it is influenced by stress [15]. Evaluating personal factors, including physical activity, is crucial for determining their work ability index [8]. Grabara et al. found that female teachers with moderate to severe physical activity levels had good work ability [10]. Micalos et al. compared paramedics and nurses, determining that nurses had lower physical activity levels [16]. Few studies have explored the relationship between physical activity levels (PAL) and work ability index (WAI) among nurses.

This study aims to examine this relationship, measuring PAL objectively and subjectively and comparing these evaluations for their effect on WAI among nurses in a hospital setting.

2. Methods

The present descriptive and analytical study was conducted for 6 months on nurses working in a hospital affiliated with Isfahan University of Medical Sciences. The main objective was to test the relationship between WAI and PAL. The data were collected using the demographic questionnaire, the WAI questionnaire, the IPAQ questionnaire, and the Xiaomi Mi Band 5 smart wristband. The IPAQ questionnaire and the Xiaomi Mi Band 5 smart wristband measured the PAL subjectively and objectively, respectively. The sample size was estimated as the correlation coefficient of the two variables of interest with a confidence interval of 95% and test power of 80%. This relationship was interpreted as statistically significant if the correlation coefficient was 0.3 or more. Finally, the sample size was estimated using the following formula:

$$P0 = 0/3$$

$$Z0 = 0/31$$

$$N = (Z_{1-\alpha/2} + Z_{1-\beta})^2 / Z_0^2 + 3$$

To compensate for the sample attrition and potential incomplete questionnaires, an attrition rate of 15% was anticipated, and the final sample size was obtained by dividing 0.85 by 85; thus, 100 nurses needed to be included in the study. To adhere to ethical rules, the following were observed: (i) obtaining written consent from nurses to participate in the study; (ii) assuring the nurses that their information would be kept confidential; (iii) thoroughly explaining the work and research steps to all nurses who participated in the study.

To conduct the study, 100 nurses were proportionally divided based on department size, with more participants from departments with a higher nurse count. A list of nurses was created for each department, and 40 were randomly selected to use the smart wristband. Inclusion criteria were (i) over two years of nursing experience at the hospital, (ii) voluntary participation, and (iii) no physical disorders (verified through medical records or individual reports). Exclusion criteria were: (i) smoking most

days; (ii) pregnancy or breastfeeding within the past 3 months. The extracted data were classified and statistically analyzed. The Work Ability Index (WAI) questionnaire measures work ability at the workplace, adapted from the Finnish Occupational Health Research Institute. Its reliability and validity were assessed by Mazloumi et al. in Iran [17]. The WAI final score ranges from 7 to 49, classifying workers as 7 – 27 (poor), 28 – 36 (moderate), 37 – 43 (good), and 44 – 49 (excellent). The IPAQ is one of the most accurate instruments for measuring physical activity levels (PAL) over the past 7 days [17].

The intensity of physical activity over the past week was measured in MET-minutes per week. MET is a unit used to estimate the energy expended during physical activity. All physical activities can be expressed as multiples of the energy consumed at rest. One MET is nearly equivalent to the energy burned in a resting state [18]. This questionnaire consists of 27 items divided into five sections: evaluation of physical activity in daily work, commuting, domestic chores, leisure time, and sedentary time. Based on the MET scores, this questionnaire categorizes individuals into three groups: low physical activity, moderate physical activity, and high physical activity.

- Low: This is the lowest level. Individuals who do not meet the criteria for Categories 2 or 3 are considered to have a 'low' physical activity level.
- Moderate: The pattern of activity to be classified as 'moderate' is either of the following criteria: (i) 3 or more days of vigorous-intensity activity (at least 20 minutes per day) OR, (ii) 5 or more days of moderate-intensity activity and/or walking (at least 30 minutes per day), OR (iii) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum total physical activity of at least 600 MET-minutes/week. Individuals meeting at least one of the above criteria be classified as 'moderate'.
- High: This category was computed to describe higher levels of participation. The two criteria for classification as 'high' are: a)

vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week, OR b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 3000 MET-minutes/week. To calculate the total intensity of physical activity in a week we used this Formula as defined in IPAQ guideline:

- Walking MET-minutes/week = 3.3 * walking minutes * walking days;
- Moderate MET-minutes/week = 4.0 * moderate-intensity activity minutes * moderate days Vigorous MET-minutes/week = 8.0 * vigorous-intensity activity minutes * vigorous-intensity days;
- Total physical activity MET-minutes/week = sum of Walking + Moderate + Vigorous MET minutes/week scores [18].

In the present study, nurses used the Xiaomi Mi Band 5 smart wristband for 7 days to measure behaviors related to occupational physical activity at work. The reason for using the wristbands for this duration was that the IPAQ also assessed physical activity levels over the past 7 days. The nurses wore the Xiaomi Mi Band 5 wristband 24 hours a day for the entire week. The data retrieved from the smart wristband includes the number of steps, distance traveled, heart rate, and PAL. This wristband calculates PAL as a total score based on height, weight, and other personal information. The device's accuracy in measuring these indices has been validated by several previous studies [19-22]. Data analysis was conducted using SPSS23 along with descriptive and analytical statistical tests. Additionally, multiple regression analysis was performed to evaluate the impact of physical activity (both occupational and general) on work ability while controlling for other demographic variables variables.

3. Results

The overall work ability and physical activity of 100 nurses were assessed. The participants' average

age was 33.12 ± 5.05 years. Regarding sex, 21% of the nurses were male, and 79% were female. One of the significant challenges during the COVID-19 pandemic was the shortage of nursing staff to provide services to COVID-19 patients. Hospitals have always struggled with a shortage of nursing staff, which became more apparent during the COVID-19 crisis.

Additionally, during the second peak of the outbreak, many nursing staff became infected, leading to their removal from service. This situation doubled the workload due to staff shortages, and the workload was high in all hospital departments. We speculated that the physical activity and work ability of personnel differ across departments.

Testing the distribution of participants in the hospital departments showed that 10% of nurses worked in the CCU, 11% in the ICU, and 18% in the emergency department. Moreover, 14% were in the operating room and maternity departments, while 10% worked in the anesthesia and other departments. The results indicated that 12% of the participants had cardiovascular disease, 21% had mild mental illness, 14% had hearing problems, 7% had anemia, and 2% had high blood pressure. The questionnaire-based assessment of Work Ability Index (WAI) in this study showed that the mean and standard deviation of WAI were 36.39 and 6.15, respectively. In this study, 7% of the participants had poor work ability, 45% had moderate work ability, 32% had good work ability, and 16% had excellent work ability. To assess the nurses' physical activity, the IPAQ was utilized. The mean and standard deviation of participants' physical activity were found to be 4310.24 and 3371.28 MET-minutes/week, respectively.

For assessing physical activity in 40 of the 100 nurses, with an average age of 30.75 ± 5.5 years, wristbands were used. The results showed that 20% of these nurses were men (n=8) and 80% were women (n=32). The wristband used in this study had a default score of 100 as a measure of physical activity. If the physical activity indicated by the wristband was above 100, it was interpreted as good physical activity, while a score below 100 indicated poor physical activity. The mean and standard deviation of physical activity among these nurses was 98.85 ± 7.87. The results showed that 12.5% of the sample (n=5) had a physical activity score of 100, 35% (n=14) had a score less than 100, and 52.5% (n=21) had a score higher than 100.

To assess the nurses' work ability in relation to the study variables, the Mann-Whitney U-test was used, indicating that the mean work ability score was higher in single nurses compared to married ones. This difference in the mean WAI scores was statistically significant between male and female nurses (p=0.032). Regarding the relationship between nurses' WAI and employment status, the Kruskal-Wallis test showed that the mean WAI score was highest among permanent nurses (i.e., 45.01). The difference in the WAI across nurses' employment status was statistically significant (p=0.01). Furthermore, in exploring the relationship between WAI and having a sideline, the results indicated that nurses with a sideline had a WAI of 33.87, while those without a sideline had a WAI of 36.60, which was statistically significant. The results of measuring the WAI by work shifts also showed that nurses with day shifts had a higher WAI (see Table 1).

The results of measuring the physical activity of male and female nurses indicated a significant difference (p=0.02), particularly concerning the mean score of physical activity by employment status. The findings showed that the mean physical activity scores for permanent and contractual nurses were significantly higher than those of other employment types (p=0.008). Finally, when assessing nurses' physical activity across different departments, there was a significant difference in the mean physical activity score among the nurses (Table 2).

Spearman's correlation test was employed to examine the relationship between quantitative variables such as age, weight, height, work experience, number of shifts, and working hours over the past week with the Work Ability Index (WAI). The findings indicated a significant negative correlation between age and the WAI. Additionally, a significant positive correlation was observed between work experience and the WAI. There was also a significant positive correlation between working hours (in a week) and the WAI. Notably, significant negative correlations were found between work ability, the number of shifts in the past week, and the WAI, as

Table 1. Correlation between work ability index (WAI) and variables of study.

Variable	Level	N.	WAI		P value
			Mean	SD	
Sex	male	21	37.09	1.29	0.557
	female	79	36.20	0.70	
Marital status	single	42	37.92	0.93	0.032
	married	58	35.27	0.79	
Shift type	day	11	43.36	1.04	0.001
	day-night	88	35.52	0.62	
Sideline	yes	8	33.87	2.15	0.04
	no	91	36.60	0.64	
Employment	Project-based	15	37.33	1.59	0.01
	contractual	10	33.54	1.90	
	temporary-to-permanent	69	36.01	0.69	
	permanent	5	45.01	1.83	
Hospital departments	general	13	35.61	1.34	0.224
	emergency	18	39.01	1.94	
	CCU and ICU	21	36.23	1.52	
	Operation room	14	37.78	1.78	
	Obstetrics and gynecology	14	34.07	1.49	
	Anesthesia	10	33.7	1.59	
	Other(s)	10	37.02	2.40	

well as between height and the WAI. No correlation was identified between the participants' weight and the WAI (Table 3).

Spearman's correlation test of the physical activity based on IPAQ and demographic variables showed a significant negative correlation between age and physical activity, weight and physical activity, and work experience and physical activity (P < 0.05). Moreover, no correlation was found between height, working hours, number of shifts within the past week and working hours per week (P >0.05) (Table 4).

Figure 1 summarizes the Spearman's test results. A significant positive correlation between physical activity assessed with the wristband and the WAI (r=0.677, P <0.01). As can be seen, one's work ability is increased with increased physical activity.

4. Discussion

The purpose of this study was to investigate the relationship between WAI and PAL in nurses. The mean index of work ability in this study was moderate. Similarly, in Rypicz et al.'s study, which aimed to investigate the work ability index in nurses, the results showed that the average work ability index was moderate. [23]. In some research by Grossi et al., nurses' WAI was found to be good. Similarly, in another study, Sivan Sobhani et al. reported nurses' WAI to be good [24].

A primary reason could be the average age of the research participants. In the study by Grossi and Sobhani, the participants had average ages of 24 and 31 years, respectively. In contrast, the nurses in the current study had an average age of 33. Consequently, younger individuals tend to have higher

Table 2. Correlation between physical activity (PA, MET-minutes/week) and variables of study.

Variable	level	n.	PA		P Value
			Mean	SD	
Sex	male	21	5892.33	4429.34	0.02
	female	79	5239.86	4876.24	
Marital status	single	42	5870.25	4860.45	0.72
	married	58	3890.24	2780.22	
Shift type	day	11	4116.23	3783.36	0.35
	day-night	88	4740.20	3670.32	
Sideline	yes	8	3790.23	2980.34	0.52
	no	91	4830.69	3760.27	
Employment	project	15	3747.66	2936.10	0.008
	contract	10	4760.21	3680.63	
	temporary-to-permanent	69	4734.24	3670.76	
	permanent	5	3679.45	3010.61	
Hospital departments	general	13	4380.22	3740.34	0.004
	emergency	18	5434.79	4842.09	
	CCU and ICU	21	4499.95	3950.78	
	operation room	14	3490.25	2933.42	
	obstetrics and gynecology	14	3298.49	2887.30	
	anesthesia	10	5225.30	4815.48	
	other(s)	10	3390.32	2993.19	

Table 3. Spearman's correlation coefficient between the final WAI score and variable of study.

Variable	Correlation coefficient (r)	P-value
Age (year)	-0.611	0.001
Weight (kg)	0.037	0.71
Height (cm)	-0.085	0.4
Work experience (year)	0.066	0.001
Work hours (h)	-0.226	0.02
Frequency of shifts (past week)	-0.422	0.001

Table 4. Correlation between the physical activity score and variables of study.

| Variable	Correlation coefficient (r)	P-value
age	-0.307	0.002
weight	-0.219	0.02
height	0.077	0.44
work experience	-0.250	0.01
work hours	-0.150	0.12
frequency of shifts in the past week	-0.10	0.92

work ability. Additionally, the survey by Selorzi et al. found that nurses' working ability was moderate, which aligns with the present study [25]. One possible explanation is the similarity in age range between Selorzi's research and the current one. The present findings reveal a significant negative correlation between Work Ability Index (WAI) and the

demographic variable of age (p <0.001), consistent with the study by Ehsan Elah Habibi et al. (p <0.05) [26]. Thus, as the age variable increases, the average WAI decreases.

Furthermore, Monteiro et al.'s study found a significant negative relationship between age and WAI, which is consistent with the current findings [27].
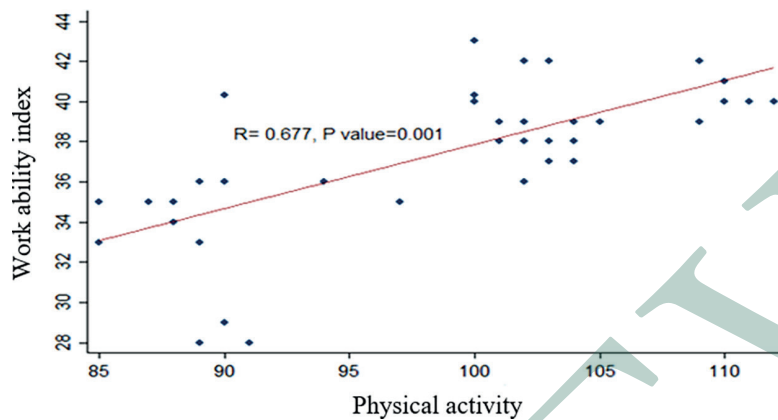
Figure 1. The relationship between the WAI and physical activity.

In the study of TIJ van den Berg to test the effect of occupational factors related to work and personal factors on the WAI as a systematic review, the results showed a significant relationship between age and the WAI [6]. Among the reasons for the agreement between the study mentioned above and the present findings is the similar research populations in the two studies. However, in the study of Bugajska J et al., to test the physical work capacity (VO2 MAX) and the WAI in employees of the Polish Electricity Bureau, the mean index was found to be positively correlated with the demographic variable of age (the age below 35 years) [28]. The reason for the contradictory findings is that the research populations were different. The results of testing WAI by different work shifts showed that nurses with day shifts had a higher work ability. This difference in nurses' work ability across different work shifts was also statistically significant (p=0.01). The mean score of this index in Costa et al.'s research has the highest value for day-night shift workers and the lowest value for day shift workers [29]. In the present study, a significant negative correlation was found between the WAI and the age variable. It can be argued that with increasing age, the level of nurses' health will decrease, which can affect the work ability index. A significant negative correlation was found between age and work ability [30].

In the present study, there was no significant relationship between BMI and work ability. The reason is that there is a significant negative correlation

between height and WAI in this study, yet no correlation between weight and WAI. In their study, Ardudri et al. found a significant correlation between BMI and WAI [30]. In fact, there was a positive and significant correlation between nurses' weight and WAI and between height and WAI. In another cross-sectional study, Giacomo Garzaro et al. investigated the relationship between physical health and WAI among healthcare workers. The results showed a significant negative relationship between WAI and age [31]. The findings showed no significant re-lationship between the department type and the WAI. In some research on nursing and midwifery hospital staff and employees of a factory, Celedova et al. found that the former had a lower work ability than the latter [32].

In Monteiro's study, the nurses of the conservative department had a higher WAI than the surgical depart-ment [27]. It is noteworthy that the present study was conducted in only one hospital. In Gharibi et al.'s study, more than one-third of workers did not have a high enough WAI. Moreover, the overall mean score of WAI was at an moderate level. In Gharibi et al.'s study, more than one-third of workers did not have an adequate work ability index (WAI < 36) [33]. In the present study, as the work ability index questionnaire showed, 12% of the participants had a cardiovascular disease, 21% mild mental illness, 14% hearing problems, 7% anemia and 2% high blood pressure. This shows that there is a significant relationship between the disease index

and the work ability index. In another study, Abdul Alizadeh et al. aimed to check the validity of the Iranian version of the WAI questionnaire. They found a significant relationship between the work ability index and affliction with a disease (p<0.05) [34] because more suffering from diseases reduces one's ability to work.

The present study found a significant and positive correlation between work experience and work ability index. So-leimani et al. showed that with increasing age and work experience, the safety attitude and knowledge and the work ability index increase [35]. In the present study, there was a negative correlation between age and physical work activity (p >0.002 and r=0.307), which was in line with the study by Legaz-Arrese A [36]. Also, Lorna H's study, which aimed to investigate the effect of individual and social factors on changes in physical activity in the working community, led to similar findings [37]. In the present study, the total mean score of physical activity was higher in men than in women, This score was 15996.76 and 6271.86 in men and women, respectively, which is similar to the study of Shook RP et al., which was conducted using an international questionnaire to measure physical activity based on physical fitness [38]. It was also consistent with the study of Vafai Najjar, which aimed to investigate the effectiveness of physical activity training in the emotional exhaustion of employees in Agh Qola city [39]. Also, Moradi et al.'s study showed that female participants had low and moderate physical activity [40]. One reason for the similarity of the findings of these studies to the present study can be the greater metabolism and, as a result, physical activity of men than women. In the study of Andrea Piccinno and Dario Colella, which aimed to test the relationship between cardiac complications and PAL in adolescents with this complication, no significant difference was found between sex and PAL [41]. One reason for the divergent findings can be that the research sample consisted of patients rather than nurses.

The results of the correlation test showed a significant negative correlation between weight and physical activity (P = 0.02, r = 0.219), which was in line with the study of Pasdar et al., which aimed to investigate the intensity of physical activity and its effect.

This study was conducted on body composition and quality of life in female employees of Kermanshah University of Medical Sciences in 2013 [42]. One reason can be that with increasing weight, one's mobility and physical activity decrease. Also, Tucker SJ's research, which aimed to investigate the effect of physical activity on working nurses with children, is also in line with the present study (P <0.03) [43]. In this study, the nurses working in the emergency department had a higher mean score of physical activity than other departments. In another study by Baghani Moghadam et al., the highest physical activity levels belonged to housewives [44].

As the present study showed, a significant relationship was found between the PAL index and WAI in both subjective and objective assessments. However, in the study of Erdodri et al., which aimed to investigate the relationship between PAL and WAI in administrative and operational jobs, no significant relationship was observed between these two indices [30]. In their study, Bugajska et al. found a significant correlation between physical activity and work ability, consistent with the present study [28]. One reason for the consistency of findings can be the effectiveness of physical activity in reducing different diseases and increasing personal abilities. However, in the study of Van Den Berg et al., which evaluated the job-related effects of individual factors on the work ability index [6], and also in the study of Grabara et al. on the relationship between physical activity and work ability among teachers, a significant relationship was found between BMI and WAI [10]. Any study may have its limitations. In this study, the following limitations are noted: (i) a significant number of nurses did not participate in the physical activity evaluation due to the time-consuming nature of completing the extended version of the physical activity questionnaire, which limits the external validity of the results; (ii) the cross-sectional study design (6 months) does not allow for any inferences about causality. Despite these limitations, the study suggests that (i) nurses should adopt healthier lifestyles to increase their physical activity, potentially improving their work ability index and reducing the risk of early retirement; (ii) a broader evaluation of physical activity within a larger statistical community of nurses should be

conducted to investigate the impact of physical activity on the work ability index; (iii) further studies should be carried out with diverse communities to explore these issues.

The present study found a significant correlation between the work ability index and physical activity (both subjective and objective evaluations). Enhancing physical activity can not only prevent overweight, boost skeletal-muscular capacity, and increase physical-mental strength, but also promote nurses' health. Given the impact of physical activity on nurses' work ability index, the present findings can be employed to develop future interventions aimed at improving nurses' health and work performance.

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