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A cross-sectional study evaluating grip strength and associated factors in Turkish nurses and nursing students

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Abstract

Background Grip strength is an important indicator of muscle strength. Nursing job demands physical power, which is related to their muscle strength. However, studies on nurses' grip strength remains lacking.

Objective This study aims to examine the differences in grip strength between staff nurses and nursing students and to identify factors associated with grip strength in nursing sample.

Method This study was designed as descriptive and analytical. Data collected from nursing students and staff nurses in Turkiye, from May 1 to September 30, 2022. A total of 200 staff nurses and 200 nursing students participated. Data tool included a participant information form, the Perceived Stress Scale-4 (PSS-4), and the Nordic Musculoskeletal Questionnaire (NMQ). Moreover, researchers assessed the anthropometric measurements using the same scale and grip strength using a digital hand dynamometer.

Results There was no significant difference in grip strength of staff and student nurses. 48.8% of participants met or exceeded Turkish normative values. 79.5% of staff nurses and 66.0% of nursing students reported musculoskeletal issues in the last 12 months. Height, waist-to-hip ratio, and neck circumference was found to be significant predictors of grip strength, explaining 57% of the variance.

Conclusion Grip strength was similar between staff nurses and nursing students, despite differences in age, BMI, and musculoskeletal issues. Height, waist-to-hip ratio, and neck circumference are key predictors of grip strength in this Turkish nursing sample. Understanding the factors influencing grip strength can help in designing targeted interventions to maintain and improve muscle strength in nursing professionals.

Keywords Hand strength, Nursing staff and students, Musculoskeletal pain

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Introduction

Grip strength is a measure of upper body strength that indicates overall muscle strength, which is also closely related to the musculoskeletal health. Moreover, it is linked to the disease development and progression, disability and mortality, or healthy aging [1, 2]. However, studies have indicated that grip strength is affected by some variables such as age, gender, country, body mass index (BMI), etc. [3, 4]. Grip strength shows an increase from childhood to early adulthood, a relatively steady increase in middle age and a decline from middle age to elderly age [3]. It also varies geographically [4]. Dodds et al. (2016) reported that grip strength was lower in developing countries compared to developed countries. In the same study, it was found that individuals with larger body sizes had higher grip strength [4].

Globally, nurses are reported to be at risk of workplace injuries or musculoskeletal disorders leading to disability and causing nurses to leave the nursing workforce [5–7]. A meta-analysis of 42 studies found that the annual prevalence of workplace injuries or musculoskeletal disorders among nurses is 77.2%. The most common areas affected are lower back (59.5%), neck (53.0%), and shoulder (46.8%) [8]. Work-related musculoskeletal injuries and disorders are not only common among nurses and cause them to leave their jobs, but are also costly to diagnose and treat. A study developed a framework for estimating the economic burden of work injuries and diseases in selected European Union countries. This study analysed data that came from The Institute for Health Metrics and Evaluation (IHME), which is an independent global health research centre at the University of Washington in Seattle. This center provides data about mortality and disability from major diseases, injuries, and risk factors across the world, which enabled the researchers to estimate the cost of work injuries. They found that Poland showed the highest overall costs as a percentage of Gross Domestic Product (GDP) (10.4%), while the Netherlands had the highest per case costs (€75,342) [9].

Nursing professionals are at risk for work injuries and diseases due to their patient care roles, such as patient handling, lifting, and positioning, as well as lifting, carrying, and pushing equipment [10]. Other factors associated with workplace injuries or musculoskeletal disorders include high levels of stress, fatigue, years of work, shift schedule, muscle mass, physical capacity, and grip strength [11–14]. Persistent stress can lead to chronically high cortisol levels. This increase in cortisol may lead to decrease in muscle mass, as well as grip strength [15]. Nursing students may also encounter unfamiliar, stressful environments and physically demanding workloads during clinical and laboratory practice [16, 17]. This may increase the risk of work-related musculoskeletal disorders among nursing students [17]. In a study conducted in Australia, nursing students were reported to experience symptoms of musculoskeletal disorders, and despite regular exercise, most of these students had poor to average health levels, as well as poor to average grip strength [18].

The literature suggests that grip strength testing is a useful tool for assessing the functional capacity of healthcare workers [11]. Factors likely to affect grip strength include age, gender, height, weight, body mass index, working hours, working time in the profession, shift work, perceived stress, exercise habits, and physical strength required during work in the clinical field [1, 3, 4, 14, 17–19]. Determining grip strength and its related factors will help develop better interventions. These interventions can improve job performance and career longevity for nurses. They will also help to protect the health of nursing students and staff. There are limited studies conducted in other countries to determine grip strength and related factors in staff nurses and nursing students [11, 18, 19]. However, to the best of our knowledge, there are no studies regarding the grip strength of nurses and nursing students in Turkiye. Some studies have investigated the grip strength of Turkish adults or elderly people with chronic diseases [20–22]. However, with regard to grip strength of nurses, we need more evidence, due to the high physical demand of nursing work [11]. Therefore, in this study, we aimed to help fill this gap on grip strength among nurses. The evidence provided with our study will contribute to the nursing field by determining the current situation of nurses' grip strength and its related factors. This will guide future targeted interventions to improve grip strength and muscular health of nurses.

In this study, the following questions were addressed: (i) Is there any difference between nurses and nursing students in terms of grip strength. (ii) Are demographic characteristics, anthropometric measurements, exercise status, perceived stress, and status of having musculoskeletal trouble in various body parts associated with the grip strength of nursing students and staff nurses? (iii) What are the predictors of the grip strength in this sample of nursing students and staff nurses?

Materials and methods

Study design, data collection process, and sample

This study was designed as a descriptive and correlational study. The data were collected from the nursing students attending the [removed for blind review], Turkiye, between May 1 and September 30, 2022. The data collection occurred in a hospital setting to ensure consistency. Three researchers conducted anthropometric measurements and grip strength assessments. These researchers were trained by the first researcher of this study on the use assessment instruments. Written protocols were

followed for these measurements. For example, participants were instructed to avoid heavy meals and intense physical activity before anthropometric measurements. They were also asked to wear light clothes to avoid false assessments. All tools were calibrated before and during the study to ensure accurate readings. Height and weight were measured for all participants with the same, calibrated, digital scale, which also had a stadiometer attached. Similarly, waist circumference, hip circumference, neck circumference, and upper arm circumference were measured with the same measuring tape (in centimetres). Grip strength was measured using a calibrated, digital hand dynamometer. (Further information about grip strength measurement is given under the data tool section.)

The inclusion criteria required participants to be at least 18 years old, to either be actively working as nurses for at least six months or to be nursing students at the university, and to have no musculoskeletal issues in the dominant hand used for grip strength measurement. Additionally, participants could not be on vacation or resting during the study, and their participation was voluntary. Participants' statements were considered verification of their eligibility to participate this study.

The study involved 200 staff nurses and 200 nursing students. Power analysis was performed to determine the adequacy of sample size. For a multiple regression model with 15 predictors, the analysis indicated that a minimum of 139 participants would be necessary for a medium effect size ($f^2 = 0.15$), a significance level of 0.05, and a power of 0.80. Our sample size of 400 participants exceeds this requirement, indicating a robust sample size for the intended analyses.

Data collection forms

The data collection form included self-reported participant information and validated scales. Later, anthropometric variables and the grip strength of the participants were measured and recorded on the same form by the research team.

Participant information form

This form consisted of items related to the descriptive characteristics of the staff nurses and nursing students, including age, gender, exercise and relaxation habits. Participants were asked about their exercise habits with a question asking if they exercise regularly (yes or no), and if yes, how many minutes per week in total. Additionally, a question asked them to self-report their typical exercise intensity categorically, as low, medium, or high intensity.

Perceived stress scale 4 (PSS-4)

This four-item scale is commonly used to measure the subjective stress of someone during the last month of health research. Each question is graded between 0 (never) and very often [4], and questions 2 and 3 are reverse-coded. The total score is determined by adding together the scores of each of the four items and can be between 0 and 16. While higher scores are correlated with more stress, lower scores are correlated with less stress [23, 24]. The Turkish validity and reliability study of the PSS-4 was performed by Eskin et al. and the Cronbach's alpha value was reported as 0.66 [24]. In this study, it was calculated as 0.80. This value is >0.70 which is regarded as a satisfactory level of reliability [25, 26].

Nordic musculoskeletal questionnaire (NMQ)

This questionnaire includes self-reported location (neck, shoulders, elbows, wrists/hands, upper and lower back, hips/thighs, knees, and ankles/feet) and severity of musculoskeletal symptoms during the past week up to the last 12 months [27]. NMQ items include effect of symptoms on leisure/work activities, and whether or not healthcare was sought. The NMQ has good construct validity and test-retest reliability when compared to clinical history, is commonly used among nurses, and has previously been validated in Turkiye with Cronbach's alpha=0.896 [28]. In this study Cronbach's alpha was found as 0.85. In our study, self-reported musculoskeletal (MSK) issues within the past 12 months were coded as 'yes' if participants indicated having trouble in any part of their body. Conversely, if participants did not report trouble in any part of their body, their response was coded as 'no'. Upper MSK complaints were calculated based on the number of issues participants reported in their upper body parts (identified as neck, shoulders, upper back, elbows, and wrists/hands) over the past 12 months. The possible range of complaints is 0 to 5. Similarly, lower MSK complaints were calculated for lower body parts (indicated as lower back, hips/thighs, knees, and ankles/feet), with a possible range of 0 to 4. The total number of MSK complaints was calculated by summing the upper and lower body complaints, resulting in a possible range of 0 to 9.

Anthropometric measurements

Height, weight, waist circumference, hip circumference, neck circumference, and upper arm circumference were measured and recorded by researchers. After this, BMI, waist/hip ratio, and waist/height ratio were calculated.

Grip strength measurement

Grip strength was measured on the dominant hand of each participant using the Jamar digital dynamometer [29]. Before measuring hand grip strength, staff nurses and nursing students were asked to take a comfortable seated position, then squeeze the dynamometer as tight as they could for 4–5 s and relax. No other body movements were allowed during this time, according to a

standardized study protocol. To obtain an average grip strength value, three consecutive measurements were made, and the average of these measurements was automatically calculated. The participant's measurement results and the Turkish reference values [22] were shared with them.

Ethical considerations

This study was conducted by the principles outlined in the Declaration of Helsinki. Ethics committee approval (Istanbul Medeniyet University Goztepe Training and Research Hospital Clinical Research Ethics Committee, December 22, 2021) and institutional permission (Istanbul Governor's Office, Provincial Health Directorate Health Services Presidency Research, Printed Publication, Announcement Content Evaluation Commission Decision dated 09.06.2022 and numbered E-15916306-604.01.01 (2022/12) were obtained prior to the implementation of the study. Staff nurses and nursing students were informed about the purpose of the study, and those who voluntarily agreed to participate in the study were asked to fill out the data collection form. Individuals who agreed to participate in the study were guaranteed the right to withdraw at any time.

Data analysis

The SPSS 22 (Statistical Package for Social Sciences, Inc., IL, USA) program was used to analyse the data. Number, percentage, mean, standard deviation, and minimum and maximum values were calculated in descriptive statistics for categorical and continuous variables. Histograms were used to determine the conformity of the data to the normal distribution. As the distribution was normal, an independent sample t-test, and chi-square test were used to compare the nursing students and staff nurses. Pearson's correlation coefficient was used to examine the relationship between grip strength and independent characteristics which were normally distributed, continuous variables. To test the predictors of grip strength, multiple linear regression analysis was performed. The level of significance was considered as $p<.05$. Participants' grip strength was compared to the published Turkish normative values by age and gender [22].

Results

Descriptive statistics

Table 1a summarizes the characteristics of sample. The total sample ($N=400$) was evenly divided between staff nurses and nursing students. The gender distribution is

Table 1a Self-reported characteristics of participants

Characteristic	All Participants (*N* = 400)	Staff nurses (*n* = 200)	Nursing students (*n* = 200)	X^2	t-test
	N (%) or M (SD)	*n* (%) or M (SD)	*n* (%) or M (SD)	*p* value	*p* value
Gender				0.908	
Female	301 (75.3%)	151 (75.5%)	150 (75%)		
Male	99 (24.8%)	49 (24.5%)	50 (25.0%)		
Age	24.80 (5.75)	28.70 (5.61)	20.91 (2.11)		< 0.001
Regular exercise				0.267	
Yes	173 (43.3%)	81 (40.5%)	92 (46.0%)	0.267	
No	227 (56.7%)	119 (59.5%)	108 (54%)		
Exercise minutes[1]	57.64 (26.49)	57.31 (27.17)	57.93 (26.04)		0.88
Exercise Intensity				0.336	
None	226 (56.5%)	120 (60.0%)	106 (53.0%)		
Low	13 (3.3%)	6 (3.0%)	7 (3.5%)		
Med	156 (39.0%)	73 (36.5%)	83 (41.5%)		
High	5 (1.3%)	1 (0.5%)	4 (2.0%)		
Reported MSK issues in the last 12 months				0.002	
Yes	291 (72.8%)	79.5% (159)	66.0% (132)		
No	109 (27.2%)	41 (20.5%)	68 (34%)		
All MSK complaints	2.50 (2.24)	3.20 (2.33)	1.81 (1.91)		< 0.001
Upper MSK complaints	1.53 (1.42)	1.87 (1.44)	1.19 (1.30)		< 0.001
Lower MSK complaints	0.975 (1.17)	1.33 (1.26)	0.62 (0.95)		< 0.001
Meditation/relaxation				0.004	
Yes	44 (11.0%)	31 (15.5%)	13 (29.5%)		
No					
Days/week for meditation/relaxation	2.15 (0.918)	2.09 (1.03)	2.29 (0.611)		0.52
Perceived Stress Scale	7.45 (2.76)	7.33 (2.78)	7.57 (2.74)		0.385

[1]Includes any participants who recorded minutes of exercise, regardless of their answer for exercise status

Table 1b Anthropomorphic measurements of participants

Characteristic	All Participants (*N* = 400)	Staff nurses (*n* = 200)	Nursing students (*n* = 200)	t-test
	M(*SD*)	*M*(*SD*)	*M*(*SD*)	*p* value
BMI	22.71 (3.63)	23.59 (3.91)	21.82 (3.09)	<. 001
Weight	63.28 (12.34)	65.60 (12.98)	60.97 (11.24)	< 0.001
Height	166.60 (8.12)	166.20 (8.48)	167.01 (7.74)	0.316
Waist circumference	75.94 (10.31)	77.86(11.56)	74.03 (8.50)	< 0.001
Hip circumference	99.19 (8.23)	99.86 (9.17)	98.52 (7.13)	0.104
Waist: Hip ratio	0.76 (0.07)	0.78 (0.073)	0.75 (0.06)	< 0.001
Waist: Height ratio	0.45 (0.06)	0.47 (0.06)	0.44 (0.04)	< 0.001
Neck circumference	33.23 (3.26)	33.52 (3.27)	32.95 (3.22)	0.080
Upper arm circumference	26.78 (3.27)	27.18 (3.52)	26.37 (2.95)	0.013
Neck: Upper arm ratio	1.24 (0.105)	1.24 (0.112)	1.25 (0.097)	0.243
Grip strength[1]	31.42 (9.69)	31.65 (9.48)	31.19 (9.91)	0.636
	N(%)	*N*(%)	*N*(%)	
Normal grip strength[2]	195 (48.8%)	95(47.5%)	100(50.5%)	

[1]Grip strength in kilograms

[2]Met or exceeded median Turkish grip strength normative values for gender and age (Ekşioğlu, 2016)

BMI: Body Mass Index

similar across groups, with approximately 75% female and 25% male participants. Staff nurses are older on average (28.70 years) compared to nursing students (20.91 years). About 43.3% of participants reported exercising, with no significant difference between staff nurses and nursing students in exercise habits or intensity ($p > .05$). However, staff nurses reported more musculoskeletal (MSK) issues in the last 12 months (79.5% vs. 66.0%), with significantly higher MSK complaints overall and specifically in both upper and lower body regions ($p < .05$). Meditation or relaxation practices were reported by 11.0% of the participants, with staff nurses engaging in these practices more than nursing students (15.5% vs. 6.5%, $p < .05$). Stress levels (the average score of the PSS-4) were similar between the groups ($p < .05$).

Anthropometric measurements of participants are summarized in Table 1b. Staff nurses have a higher average BMI (23.59) compared to nursing students (21.82), with corresponding higher average weight (65.60 kg for staff nurses vs. 60.97 kg for nursing students). Height is similar between the groups. Staff nurses also have larger waist circumferences (77.86 cm vs. 74.03 cm) and higher waist-to-hip (0.777 vs. 0.750) and waist-to-height ratios (0.468 vs. 0.442). Hip circumference is slightly higher in nurses, but not significantly different ($p < .05$). Neck circumference and upper arm circumference are both larger in nurses, with the latter being significantly different. There is no significant difference in grip strength between staff nurses and nursing students ($p < .05$). Of the total sample, 195 (48.8%) met or exceeded the median Turkish grip strength normative values for gender and age.

Table 2 Correlation of grip strength and independent characteristics

Variable	*n*[1]	Correlation Coefficient[2] (*r*)	*p*-value
Age		−0.054	0.286
BMI		0.224	< 0.001
Weight		0.545	< 0.001
Height		0.696	< 0.001
Waist circumference		0.421	< 0.001
Hip circumference		0.154	0.002
Waist: Hip ratio		0.507	< 0.001
Waist: Height ratio		0.177	< 0.001
Neck circumference		0.647	< 0.001
Upper arm circumference		0.456	< 0.001
Neck: Upper arm ratio		0.074	0.139
Exercise (min/wk)	174	0.249	< 0.001
Meditation (days/wk)	44	0.270	0.070
Exercise Intensity (low, med, high)	174	0.114	0.133
Perceived Stress score		−0.195	< 0.001
# of MSK problems	291	−0.132	0.008

[1]*N* = 400 unless otherwise indicated

[2]Pearson correlation

Correlation analysis

Table 2 presents the Pearson correlations between grip strength and various anthropometric measurements, exercise habits, meditation frequency, perceived stress scores, and the number of musculoskeletal (MSK) complaints.

Among anthropometric variables, BMI, weight, height, waist circumference, hip circumference, waist-to-hip ratio, waist-to-height ratio, neck circumference, and upper arm circumference demonstrated significant positive correlations with grip strength ($p < .05$).

Exercise frequency was also positively correlated with grip strength while perceived stress scores and the number of MSK problems were negatively correlated. Variables such as age, meditation frequency, and exercise intensity did not show significant correlations.

Predictors of grip strength

Variables with an absolute *r* of 0.20 or higher were considered associated with grip strength [30], and added to the multiple linear regression analyses.

In the first multiple linear regression analyses, BMI, weight, height, waist circumference, waist to hip ratio, neck circumference, upper arm circumference and minutes of exercise were added to the model as predictors of grip strength. Variance Inflation Factors (VIF) were checked to assess the level of multicollinearity between independent variables (Table 3a).

According to VIF values, VIF = 1 implies no multicollinearity, and 1 < VIF < 5 indicates low-level multicollinearity [30]. Therefore, weight was excluded due to high multicollinearity. Then, multiple linear regression analysis was rerun and multicollinearity was checked again. Waist circumference were excluded due to high VIF value. After multicollinearity was eliminated, the final multiple linear regression analysis was performed and is shown in Table 3b. In the final model, only height, waist to hip ratio, and neck circumference were significant positive predictors of grip strength, and explained 57% of the variance (Table 3).

Table 3a VIF values of predictors

	First Model	Second Model	Final Model
Predictors	**VIF Values**	**VIF Values**	**VIF Values**
BMI	22.570	5.216	2.506
Height	10.375	2.098	1.943
Weight	36.933	Excluded	Excluded
Waist circumference	8.997	8.538	Excluded
Waist-to-hip ratio	2.858	2.833	1.639
Neck circumference	3.230	3.215	3.215
Upper arm circumference	3.935	3.750	3.643
Exercise Minutes	1.182	1.145	1.127

Note: VIF = 1 shows no multicollinearity and 1–5 shows low level of multicollinearity

Table 3b Regression analyses of variables correlated with grip strength

Final Model	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
(Constant)	-102.540	11.558		< .001
BMI	− .139	0.220	− .051	0.529
Height	0.518	0.084	0.434	< .001
Waist-to-hip ratio	28.646	10.243	0.182	0.006
Neck circumference	1.024	0.286	0.326	< .001
Upper arm circumference	− .187	0.296	− .061	0.529
Exercise Minutes	0.008	0.019	0.024	0.660

$R^2 = 0.587$, Adjusted $R^2 = 0.567$

Discussion

This study aimed to examine grip strength and its predictors in a sample of Turkish nurses. Initially, we aimed to determine whether there are differences in hand grip strength between nursing students and staff nurses. Then, we sought to investigate the relationship between grip strength and various factors, including demographic characteristics, anthropometric measurements, exercise habits, perceived stress levels, and the presence of musculoskeletal issues in different body parts. Lastly, we aimed to identify the predictors of grip strength within this nursing sample. The results, based on a Turkish nursing sample of 400, provide several insights into their grip strength and related factors.

Firstly, grip strength was found to be similar between nursing student and staff nurses despite significant differences in age, reported musculoskeletal issues, and some anthropometric measurements of participants. In line with our results, in a cross-sectional study with 316 participants (18 to 59 years) at a large teaching hospital in India, mean grip strength did not significantly differ between nursing staff and nursing students [14]. In our study, staff nurses had higher BMI and weight compared to nursing students. In addition, the prevalence of MSK issues among nurses (79.5%) were higher than nursing students (66.0%) which is concerning. The significantly higher rates of MSK complaints in both upper and lower body among staff nurses highlight the physical demands and potential occupational hazards associated with nursing work [6]. These findings underscore the need for targeted ergonomic interventions and preventive strategies to reduce the risk of MSK disorders in nursing professionals [11]. However, the exercise habits, duration, and intensity were found to be similar between the two groups in our sample. This similarity in exercise patterns might explain the comparable grip strength results observed. Stress levels were found to be similar between staff nurses and nursing students that may be related to their respective roles and responsibilities. Interestingly, a higher percentage of staff nurses (15.5%) reported engaging in meditation or relaxation practices compared to nursing students (6.5%). This could reflect a greater awareness or need among staff nurses to manage stress and promote mental well-being, potentially as a coping mechanism for their demanding work environment [31].

Secondly, our study findings showed that grip strength was significantly correlated with several anthropometric measures, including BMI, weight, height, waist circumference, waist-to-hip ratio, neck circumference, and

upper arm circumference. Existing literature also supports these findings. For example, a study conducted in Turkiye with 913 healthy young adults aged 18–30 years found that grip strength had a significant relationship between weight, height, BMI, mid-upper arm circumference, triceps skinfold thickness, waist circumference, and neck circumference ($p<.001$) [32]. There are limited studies examining the relationship between anthropometric measures and grip strength in nursing settings. One study investigated height, weight, and waist circumference as an indicator of grip strength in an Indian nursing sample, and reported that BMI and waist circumference significantly correlated with grip strength [14].

Additionally, among those who exercised, there was a positive correlation between grip strength and the duration of exercise, although not with exercise intensity and relaxation/mediation habits in our study. This suggests that both body composition and regular physical activity contribute to muscle strength [33]. Scores of perceived stress and number of reported MSK problems were negatively associated with grip strength in our study. Perceived stress leads to increased production of stress hormones such as cortisol. High levels of cortisol breaks down muscle and increases fat mass. The loss of muscle could explain why perceived stress is negatively associated with grip strength. For the relationship between MSK problems and grip strength, in line with our study, a cross-sectional study found that participants with grip strength at or above the national average had significantly lower odds of self-reported orthopaedic problems. This study showed that these participants had a 135% reduced chance of experiencing MSK problems compared to those with grip strength below the national average [11]. These findings support the well-known fact in the literature that grip strength is a key measure of muscle strength and overall health.

Lastly, the multiple linear regression analysis identified height, waist-to-hip ratio, and neck circumference as significant predictors of grip strength, explaining 57% of the variance. In line with our study, grip strength was significantly associated with BMI and waist circumference, explaining 76% of the variance in Indian nursing sample [14]. Another study also found a significant relationship between neck circumference and grip strength, however, it was insignificant in the regression analysis, showing neck circumference was not a predictor of hand grip strength in a Mongolian sample of 2709 participants, aged 13 to 70 years. In the same study, waist circumference did not show any significant link with grip strength. In our study, neck circumference was found to be within normal ranges (neck circumference <34 cm for women and <37 for men [34]). Similarly, waist-to-hip ratio was within the healthy range in our sample with 0.90 or less for men, and 0.80 or less for women [35]. These two anthropometric measures are considered to be upper body obesity indicators, highlighting the issue of decreased muscle mass and increased body fat. Our results showed a relatively fit sample, with healthy neck circumference and waist-to-hip ratios, which were significantly positively correlated and predictive of grip strength.

To maintain a desired grip strength, nurses' physical and mental well-being is critical. Based on evidence-based practice, literature suggests some interventions such as stress reduction and resilience interventions, yoga and mindfulness-based interventions, and workplace exercise and nutrition interventions to improve nurses' physical and mental well-being may be helpful [36, 37]. A systematic review showed that mindfulness-based interventions, cognitive-behavioral therapy (CBT), and Stress Management and Resiliency Training were effective in reducing stress among nurses. However, interventions aimed at improving physical health parameters like BMI or blood pressure showed limited success, due to the difficulty in making lasting lifestyle changes [37]. Therefore, additional strategies may be needed to address the challenges of achieving significant physical health improvements.

Implications for nurses

Understanding the factors influencing grip strength has some important implications for nursing practice. Nurses' physical strength can directly affect the quality of patient care. Therefore, since grip strength is an important indicator of overall muscle strength, interventions for improving grip strength can enhance nurses' ability to meet the physical demands of their job. Regular exercise programs should be promoted among nurses to sustain muscle strength and overall physical health. Additionally, ergonomic practices should be implemented and emphasized to minimize the risk of musculoskeletal issues, which were found to negatively correlate with grip strength. Stress reduction strategies are also crucial, as stress was identified as a negative factor influencing grip strength. These strategies could include mindfulness training, relaxation techniques, and providing support for work-life balance. By focusing on these areas, healthcare organizations can help ensure that nurses maintain the necessary physical strength and overall well-being required.

Limitations of the study

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design prevents establishing causality between the predicting factors and grip strength. Second, the study was conducted in a specific geographic location and within specific institutions, which may limit

the generalizability of the results. Third, self-reported data on exercise habits, stress levels, and musculoskeletal complaints may be subject to recall and social desirability biases. Therefore, this may affect the accuracy of interpretations. Fourth, we used the Perceived Stress Scale-4 (PSS-4) and Nordic Musculoskeletal Questionnaire (NMQ), which may provide a broad overview but may lack the depth of more comprehensive assessments. Finally, the study could not include other factors that could influence grip strength, such as dietary habits, sleep quality, etc. These factors could contribute to a broader understanding of grip strength. We recommend future researchers address these limitations by incorporating a more diverse sample, using longitudinal designs with mixed methods, and including additional variables to provide a more comprehensive analysis of the factors affecting grip strength in nursing professionals.

Conclusion

In summary, this study provides valuable insights into the grip strength of a Turkish nursing sample by investigating the relationships between demographics, anthropometric measurements, exercise habits, perceived stress, and MSK problems. Our study highlights the significant associations of grip strength with anthropometric measures, exercise duration, stress, and MSK problems. These results confirm that grip strength as a reliable measure to predict overall muscular strength and the potential risks of musculoskeletal pain, injuries, or disorders. Furthermore, our results indicate that only three variables, height, neck circumference, and waist-to-hip ratio stand out significantly as predictors of grip strength in this sample. These results underscore the importance of targeted interventions to maintain healthy grip strength among nurses.

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Author contributions
The conceptualization of this study was driven by L.R.R and A.C.A. Data collection was performed by C.S. Subsequently, data analysis were completed by S.A., S.D., L.R.R., and S.S. Manuscript was written by C.S., A.C.A., L.R.R., S.A., and S.S. Additionally, critical revisions for important intellectual content was driven by L.R.R. Ultimately, all authors have read and agreed to the published version of the manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The ethics committee (Istanbul Medeniyet University Goztepe Training and Research Hospital Clinical Research Ethics Committee, December 22, 2021) approved this research. Following ethical approval, institutional permissions (Istanbul Governor's Office, Provincial Health Directorate Health Services Presidency Research, Printed Publication, Announcement Content Evaluation Commission Decision dated 09.06.2022 and numbered E-15916306-604.01.01 (2022/12) were granted to collect the data. Written informed consent to participate in the study was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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