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Prevalence and Characteristics of Forward Head Posture among University Students

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ABSTRACT

Introduction: Forward head posture (FHP) is a condition of misalignment in the cervical vertebrae where the cervical spine shifts towards a more anterior angle. This change induces stress on the surrounding anatomical structures, leading to comorbidities and pathology. FHP has been identified as prevalent among young adults. Various risk factors contribute to this demographic's high burden of FHP, including increased exposure to modern technologies, such as smartphones. Therefore, our study aims to investigate the prevalence of FHP among university students in our center and analysed risk factors associated with FHP.

Methods: This cross-sectional study was conducted on students of Universitas Muhammadiyah Semarang. A total of 126 participants were enrolled. Diagnosis of FHP was determined by measuring the craniovertebral angle (CVA) using ImageJ. Data of risk factors was collected by questionnaire, smartphone addiction scale-short version (SAS-SV) and the neck pain disability index. Ethical approval was obtained from the ethics committee of Universitas Muhammadiyah Semarang and participants provided informed consent.

Results: The prevalence of FHP in our center was 63.5%. The mean CVA was 48±6o. We discovered that overweight or obese participants had almost 4 times the odds of developing FHP (aOR=3.899, 95%CI [1.3;11.6], p=0.014). A similar trend was also observed in participants with smartphone addiction, who were 4.5 times more likely to develop FHP (aOR=4.41, 95%CI [1.76;11.04], p=0.002). We did not observe a significant association between FHP and neck pain.

Conclusion: Our study demonstrates the considerable prevalence of FHP in our center, especially in those with higher BMI and addiction to smartphones. However, we advise caution in interpreting this study to a broader population of students due to its small sample size and cross-sectional design. We recommend larger longitudinal studies analysing strategic risk factors of FHP to construct a basis of policymaking for effective prevention and targeted intervention.

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INTRODUCTION

Forward head posture (FHP) is an abnormal condition found in the cervical vertebrae segments in which the cervical spine's positioning is directed more towards the anterior (1,2). In FHP, the head will change position from its physiologically normal angle towards a more anterior position causing a shift in the center of gravity (1, 3, 4). This abnormal condition will accumulate stress on the muscles of the neck leading to various comorbidities such as neck pain, headaches, and muscular imbalance. Long-term exposure to FHP can cause persistent spinal malformation, especially in the segments of the neck responsible for extension.(1) Furthermore, previous studies on FHP have shown its association with limited rotation of the neck (1, 5, 6).

FHP is a common fault in a sagittal plane posture discovered in all age groups, presenting with varying levels of severity and progression (1, 2). Various studies among young adults have shown they are susceptible to developing FHP (7-9). The prevalence of FHP in young adults ranged from 11.4% - 67% as stated in different studies conducted in various institutions across different countries (8-10). Various risk factors are associated with FHP, such as age, gender, and prolonged improper body posture (11, 12). In young adults mainly, the increased exposure of this age group to the use of diverse technologies such as smartphones has further caused an increased risk of developing FHP (13-15). Several studies have highlighted the causative relationship between FHP and chronic fatigue due to excessive muscle activity (16, 17).

Chronic fatigue itself is also often related to a reduction in performance (18, 19). Additionally, epidemiological data regarding FHP in Indonesia is still insufficient which we predict is the underlying cause of a low number of initiatives addressing FHP prevention and targeted management. Therefore, given the potential detrimental effects of FHP, it is crucial to determine its prevalence and related risk factors among Indonesian university students (20-22). This study aims to fill this gap by first determining the prevalence of FHP among university students in our center. We then aim to elucidate the characteristics of these students with FHP to further understand the risk factors that these students present. Finally, we attempt to assess the association of FHP with neck pain.

METHOD

Study design

This cross-sectional study was conducted on 126 university students from our university (Universitas Muhammadiyah Semarang). Samples were collected as convenient sampling, excluding participants who did not consent and those with a history of vertebral trauma, vertebral deformities, and surgery to the vertebrae. The ethics committee of Universitas Muhammadiyah Semarang approved this study.

Determination of forward head posture

FHP was determined by measuring each participant's craniovertebral angle (CVA). A participant with a CVA of less than 50 degrees was considered as having FHP. A photo of each participant was taken from the side with an approximate distance of 1 meter. The tragus, seventh cervical vertebrae, and shoulder were visible in all documented photographs. The participant was positioned straight upward with their hands and arms at their side. CVA was measured using the imaging software ImageJ (National Institute of Health). By utilizing ImageJ, a line was drawn through the tragus and C7. Another horizontal line was drawn to intersect with the diagonal line mentioned above at the height of C7 to create a measurable angle. Every photo was taken from a similar distance, with a calibrated camera producing similar-quality images. The inter-rater reliability of measurements was analysed prior to data collection using the intraclass correlation coefficient (ICC) which produced excellent reliability between two independent observers (ICC=0.945).

Photos were taken from the side. The distance between the participant and camera was approximately 1 meter. The tragus, shoulder, and the 7th cervical vertebrae were clearly visible. A diagonal and horizontal line were drawn according to anatomical landmarks to create a measurable CVA.

Figure 1. Illustration of Photo Measuring the CVA of a participant.

Investigation of risk factors

We analysed the association of several risk factors for FHP, including age, gender, body mass index (BMI), and smartphone usage. We measured the weight of participants using a calibrated digital weight scale and height using a mounted measuring device. Smartphone usage was identified through the duration of use and by utilizing the smartphone addiction scale short version (SAS-SV) questionnaire to assess addiction to smartphones.

Analysis of neck pain

Participants' neck pain was identified and assessed using the Neck Disability Index (NDI) questionnaire. Two reviewers tabulated and graded each participant's result.

Statistical analysis

Numerical data are presented as mean±SD (BMI, age, CVA). Other data points such as gender, categories of BMI, usage of smartphones and neck disability index are presented as categorical variables. Comparison between groups were conducted using an unpaired two tailed T-test when appropriate. Measures of association between groups of categorical values were conducted using Fischer's exact test. Effect size of association was presented as crude and adjusted Odds ratio. Statistical analyses were conducted using GraphPad Prism Version 10 (GraphPad Software, San Diego, California, USA), IBM SPSS Statistics Version 27 (IBM Corp), and Microsoft Excel. P-value of less than 0.05 was considered significant for all statistical measures.

Ethical considerations

This study was approved by the Health Research Ethics Committee of Universitas Muhammadiyah Semarang. All included participants provided informed consent.

RESULTS

This cross-sectional study was conducted on university students of Universitas Muhammadiyah Semarang and included a total of 126 participants.

Descriptive statistics

At baseline, the mean age of participants was 21±0.75. There were more female (72.2%) than male (27.8%) participants. The mean BMI value was 23±4 kg/m2 with 27.7% of participants entering the category of overweight or obese. Out of 126 participants, the prevalence of FHP in our study was 63.5% with a mean CVA of 48±6°. Most participants scored highly on the SAS-SV questionnaire indicating addiction to smartphones (77%) with most participants using their smartphones for more than 7 hours each day (81.7%). The mean score of SAS-SV was 34±6.7. Participants mostly complained of minimal disability in the Neck Disability Index questionnaire (93.7%). Table 1 presents the complete baseline characteristics of our study cohort.

Table 1. Baseline characteristics of participants

Characteristics	N (%)
Gender	
Males	35 (27.8)
Females	91 (72.2)
Smartphone usage (daily)	
≤7 hours	23 (18.3)
>7 hours	103 (81.7)
BMI	
<18,5 kg/m^2	11 (8.7)
18.5-24.9 kg/m^2	80 (63.5)
25-29.9 kg/m^2	24 (19)
≥30 kg/m^2	11 (8.7)
Forward Head Posture	80 (63.5)
Yes	46 (36.5)
No	
Smartphone addiction (SAS-SV)	
Yes	97 (77)
No	29 (23)
Neck disability index	
Minimal	118 (93.7)
Moderate	8 (6.3)

Risk factors of FHP

After collecting baseline characteristics, we then analysed whether these characteristics were different between those categorized as FHP with those who are not. As shown in Figure 2A, we identified that those with FHP had a significantly higher mean BMI than those without FHP (24.10±4.83 kg/m2 vs 21.77±3.18; P=0.004). This suggests that BMI can present as a risk factor for FHP. Therefore, we further demonstrated that there was a significant association between participants who were either overweight or obese with developing FHP (OR 4.92; P=0.0017). Another known risk factor for FHP analysed in this study was the use of smartphones. Although we did not find any significant association between duration of smartphone use with FHP, we did elucidate a significantly higher SAS-SV score in participants with FHP (35.46±5.64 vs 31.63±7.56; P=0.0013) (Figure 2B). Furthermore, a higher SAS-SV score indicating addiction was also significantly associated with FHP (OR 4.926; P=0.0004). Table 2 presents the complete analysis of risk factors.

Table 2. Association analysis of risk factors for FHP

Risk Factor	Forward head posture		cOR(95%CI) *, P-value
	Yes (%)	No (%)	
Gender			
Males	24 (68.6)	11 (31.4)	0.463
Females	56 (61.5)	35 (38.5)	
Smartphone usage (daily)			
≤7 hours	16 (69.6)	7 (30.4)	0.503
>7 hours	64 (62.1)	39 (37.9)	
BMI			
<18,5 kg/m^2	6 (54.5)	5 (45.5)	
18.5-24.9 kg/m^2	44 (55)	36 (45)	4.92 (1.801;12.41), 0.0017
25-29.9 kg/m^2	21 (87.5)	3 (12.5)	
≥30 kg/m^2	9 (81.8)	2 (18.2)	
Smartphone addiction			
Yes	70 (72.2)	27 (27.8)	4.926 (2.068;12.29), 0.0004
No	10 (34.5)	19 (65.5)	

*When significant and applicable, cOR (crude Odds Ratio)

(A) Displays the comparison of BMI (kg/m^2) and (B) SAS-SV score between the FHP and non-FHP group on a histogram with error bars presenting mean±SEM. The unpaired two-tailed t-test showed that both BMI and SAS-SV score of participants in the FHP group was significantly higher than the non-FHP group. **P<0.01, Body Mass Index (BMI), Smartphone Addiction Scale Short Version Questionnaire (SAS-SV)

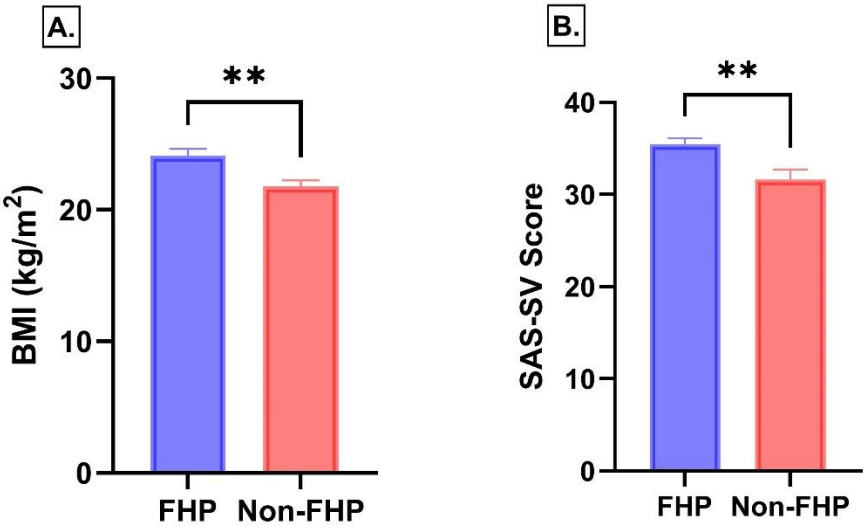

Figure 2. Analysis of Risk Factors for FHP

To strengthen the association between these risk factors and the occurrence of FHP, we further analysed BMI and smartphone addiction after adjusting for other risk factors stated above. A BMI of overweight or obese and smartphone addiction was still strongly associated with increased odds of developing FHP. Table 3 presents the adjusted results of these risk factors.

Table 3. Association analysis of risk factors for FHP after Adjustment

Risk Factor	aOR(95%CI) *, P-value
Gender	0.767
BMI	3.899 (1.31;11.59), 0.014
Smartphone addiction	4.408 (1.76;11.04), 0.002

*When significant and applicable, aOR (adjusted Odds Ratio)

Neck pain in participants with FHP

Finally, we identified whether there is an association between FHP and neck pain. There was no significant difference between the groups (FHP vs non-FHP; 8.01±7.38% vs 8.67±7.64%; P=0.63) with no significant association of FHP with a higher grade of disability. Table 3 displays the analysis and comparison of the neck disability questionnaire in the FHP and non-FHP group.

Table 4. Association analysis of FHP and neck pain disability index

	Neck Pain Disability Index		P-value
	Minimal Disability	Moderate Disability	
Forward Head Posture			
Yes	75	5	0.952
No	43	3	

To investigate further the lack of association between FHP and neck pain, we conducted a subgroup analysis of our participants based on gender and BMI. The results were consistent in that there was no significant association in the female subgroup (P=0.68), obese/overweight subgroup (P=0.276), and the normal weight subgroup (0.68). We did not analyse the male subgroup since all participants reported neck pain with minimal disability. We also did not conduct a subgroup analysis of age groups since the participant's age range is small (20-22 years old).

DISCUSSION

Interpretation of Key Findings

In this study, we discovered that the prevalence of FHP amongst university students in our centre was 63.5%. We adopted the CVA threshold of 50° according to a study done by Silva and Suwaidi (2, 23). Then, we identified that participants with FHP had a significantly higher BMI than those without FHP. A significant association was also discovered between participants who were overweight or obese with FHP. Our study also demonstrated that university students spend a large amount of time using their smartphones with 81.7% of our participants reporting >7 hours/day smartphone usage. We further analysed this by using the SAS-SV questionnaire and discovered that 77% of our participants fulfilled the criteria of smartphone addiction. Participants with FHP also had a significantly higher SAS-SV score than those without FHP with a significant association of smartphone addiction to developing FHP. The SAS-SV questionnaire was chosen because it has shown good validity and reliability in multiple studies (24, 25). Finally, our study did not find any significant correlation between FHP with neck pain using the Neck Disability Index. The Neck Disability Index have also been shown in previous studies to have great reliability with a high internal consistency and test-retest reliability (21, 26).

Comparison with Previous Studies

The prevalence of FHP at our centre was comparable to results obtained by Naz and colleagues in a study conducted in Pakistan involving 197 students, where they discovered the prevalence of FHP as 63.96% (8). However, our result was much smaller than the prevalence discovered by Singh et al. in students of Adesh University, India (73%) (4). Furthermore, our results were consistent with global studies in young adults which stated the prevalence of FHP to range from 11.4% - 67% (8-10, 27). It can be inferred that the prevalence of FHP does vary according to location of study and demographics. Interestingly, differing methods of measurement did not seem to greatly affect the diagnosis of FHP. Naz et al. used the plumb line method to diagnose FHP which resulted in a similar prevalence to our study which diagnosed FHP by analysing CVA using two intersecting lines (8).

The data we obtained regarding BMI and its association with FHP was also in line with previous studies. Kilinc and colleagues conducted a similar method of observation and discovered a similar trend in which a higher BMI was correlated with a more severe anterior tilt of the head and a lower craniovertebral angle (28). Another study by Kocur et al. also stated similar findings in which BMI was moderately correlated with CVA (29). This correlation was not surprising as various groups have described the detrimental effects of obesity on postural stability. Obese individuals often present with an increased distribution of body fat, leading to postural instability (30, 31). We predict that the excessive and chronic fat deposition in the neck compartment significantly increased the burden of deep cervical flexors, such as the longus colli and capitus muscles, causing overcompensation and asymmetry.

We also discovered that university students spend a large amount of time using their smartphones. Our results greatly differ from a study done by Haug et al. in Switzerland. Utilizing the same SAS-SV questionnaire, smartphone addiction only occurred in 16.9% of their participants (32). The large sample size of their study and the difference in demographics especially the socioeconomic condition of participants might explain this occurrence. Our findings were consistent with the discoveries of Jung and colleagues (13). They stated that prolonged smartphone use negatively affects CVA and respiratory function (13). We hypothesize that improper ergonomic habits in using smartphones are the underlying cause of this occurrence. Bad ergonomic habits tend to cause unbalanced muscle contractions, eventually leading to asymmetry and improper posture.

Finally, we did not find any significant correlation between FHP and neck pain. Interestingly, Damasceno and colleagues also elucidated that there was no significant correlation between abnormalities in neck posture due to mobile phones with neck pain (20). We hypothesized that the age group of our participants might contribute greatly to the resistance of neck pain. As elucidated by Mahmoud and colleagues, FHP was significantly correlated with neck

pain in adults and older adults (1). Further supporting this, Damasceno et al did not find any significant correlation between abnormalities in neck posture caused by mobile phones with neck pain in young adults and adolescents.(20)

Implications for Public Health

We discovered that a higher BMI and addiction to smartphones were significantly associated with FHP. This is a major health problem, because addiction to smartphones was also significantly correlated to sedentary activity and thus causing higher BMI.(33, 34) We hypothesize that participants with addiction to smartphones, spend less time conducting physical activity which then lead to an increased BMI causing persistent symptoms of FHP. Several groups have highlighted the effectiveness of ergonomic training in reducing musculoskeletal disorders.(35-37) Therefore, it would be beneficial for regulatory agencies to implement policies to increase the awareness of the community and to provide basic ergonomics training for smartphone users. This can be implemented through mandatory modules when initially purchasing a smartphone.

Limitations and Cautions

Although this study successfully displayed the prevalence of FHP and some of its characteristics, there were a few limitations that need to be addressed. Firstly, due to the small sample size, we could not apply a rigorous sampling method such as probability sampling. Therefore, we advise caution in interpreting the obtained results to a broader population of university students. Our attempt to mitigate sampling bias was conducted by comprehensively sampling all students available at our faculty throughout the duration of our study. We also could not conduct more rigorous regression models with other risk factors that might affect the occurrence of FHP due to limited time and resources. Due to its non-longitudinal nature, this study has limited reliability for inferential conclusions about risk factors of FHP. Other biomechanical muscle parameters that might be affected by FHP was also not discussed in this study.

Recommendations for Future Research

Future studies should elaborate on the biomechanical characteristics of muscles involved in FHP to comprehensively elucidate the mechanical characteristics of this disease. A more detailed association between FHP and comorbidities such as neck pain should also be investigated in this age group of young adults and adolescents. Conducting longitudinal studies to elicit an inferential effect of risk factors for FHP and neck pain will also highly benefit this research field. Finally, we suggest investigating effective mitigation strategies and rehabilitative methods for populations at high risk of developing FHP.

CONCLUSION

FHP was prevalent among university students in our center. A higher BMI and addiction to smartphones was discovered to have a significant association with developing FHP. However, we did not find a significant association between FHP and neck pain likely due to the high resilience of this age group to neck pain. This study presents the need to further investigate FHP, especially in the younger population and in those with increased exposure to diverse technologies such as smartphones. Longitudinal studies should be conducted to strengthen inferential conclusions about FHP and its risk factors. This will provide opportunities to identify various strategies to prevent the occurrence of FHP in this age group, such as developing initiatives that encourage ergonomically safe practices when using smartphones.

AUTHOR'S CONTRIBUTION STATEMENT

Lukman Faishal Fatharani – Primary investigator, data collection, data analysis. Rina Purnamasari – Data collection, data analysis, manuscript writing. Mohammad Raihan Diki Ramadhan – Data collection, data analysis. Galih Prakasa Adhyatma – Data collection, data analysis, manuscript writing

CONFLICTS OF INTEREST

There was no significant conflict of interest in conducting this research.

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