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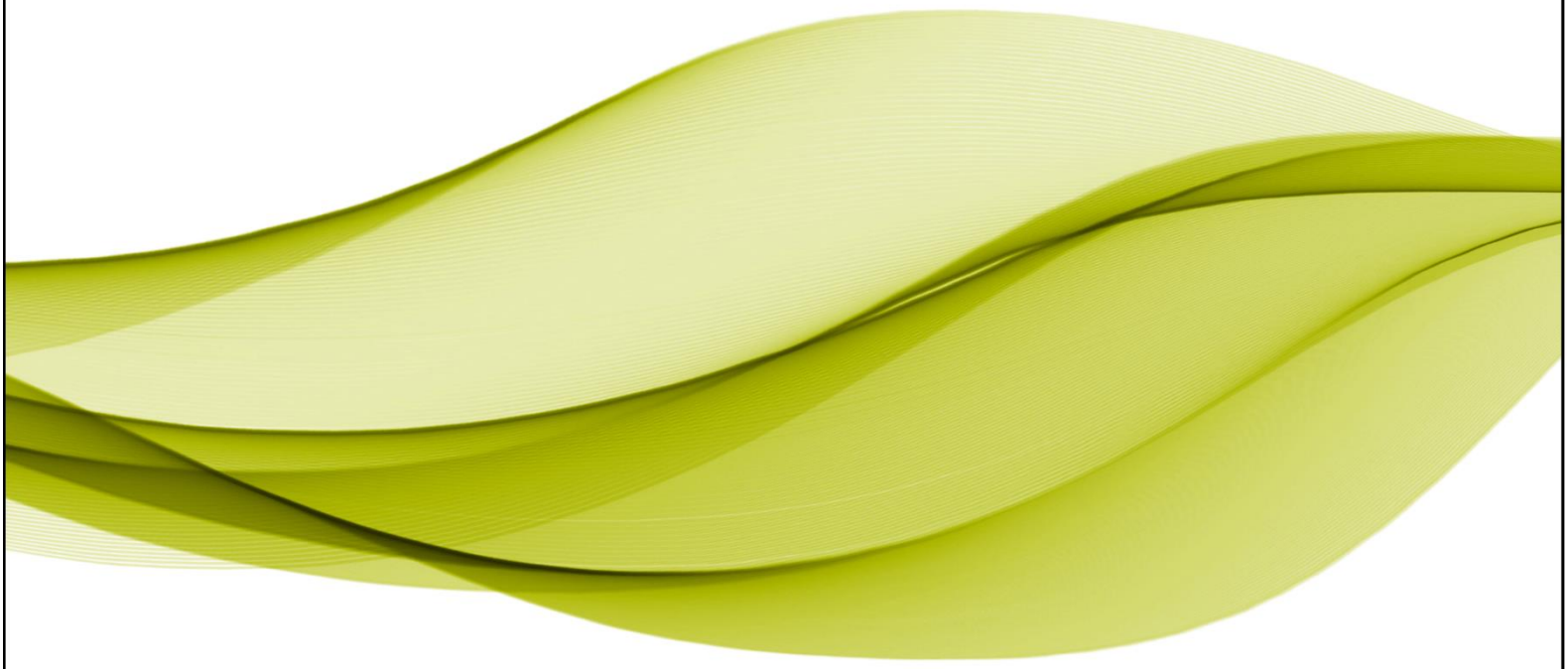

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Knowledge, Awareness, and Perceived Barriers Regarding Cervical Cancer Screening Among Bangladeshi Women Suffering from Cervical Cancer: A Cross-sectional Study

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Knowledge, Awareness, and Perceived Barriers Regarding Cervical Cancer Screening Among Bangladeshi Women Suffering from Cervical Cancer: A Cross-sectional Study

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Abstract

Background: This study aimed to evaluate the knowledge, awareness, and perceived barriers regarding cervical cancer screening among women in Bangladesh.

Methods: A hospital-based survey was conducted from January to April 2021 among 200 female participants. Statistical analysis of this study was performed by using Stata 13 (StataCorp LP, 4905 Lakeway Drive, College Station, TX 77845, USA), where Chi-square test was used for the determination of the correlation among different variables.

Results: Among the participants, 86.5% were rural residents, 96% were married, 87.5% were housewives, 47% were uneducated, and 93.5% lived on a husband's income. Moreover, 84.5% hadn't any family history of cancer, 91.5% had no knowledge about cervical self-examination, 74.5% and 61.5% never heard of screening programs and cervical cancer, respectively ($p < 0.05$). In addition, 23.5% knew that early sexual activity was a risk factor for cervical cancer. Again, the outcome of ideas about other people's thinking (6%), the stigma of cancer diagnosis (15%), difficulty talking with doctors (5%), poor knowledge (12.5%), and fear of physicians and examiners (5%) were statistically significant ($p < 0.05$).

Conclusions: This study revealed that most female respondents lack knowledge and awareness regarding cervical cancer. To improve this situation, appropriate and socially acceptable awareness programs are necessary.

Keywords: awareness, barriers, cervical cancer, knowledge, screening

INTRODUCTION

Cervical cancer is the second most common cancer in women globally after breast cancer. Data suggest that human papillomavirus (HPV) infection causes cervical neoplasia. Malignant transformation is more likely to occur when high-risk HPV genital subtypes are present.[1] Early screening is necessary for cervical cancer detection; however, knowledge about early screening and uptake is very poor in developing countries.[2] On the contrary, in affluent countries, widespread adoption of the Papanicolaou smear has drastically lowered the prevalence of cervical cancer. The early detection of aberrant cytologic alterations early and accurately prevents the disease from progressing from being preinvasive to invasive.[3]

HPV spreads from one person to another during sexual activity. HPV will infect at least half of sexually active adults at some point in their lives; however, only a small percentage of women will develop cervical cancer.[4] The severity of the infection is determined by its size, extent of spread, and overall health. Cervical cancer was diagnosed in approximately 570,000 women worldwide in 2018, with approximately 311,000 women dying from the disease.[5] HPV can cause skin warts, genital warts, and other skin problems. Other symptoms are related to the vulva, vagina, anus, tongue, penis, and tonsils. The

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main symptom is unexpected vaginal bleeding. In addition, pain during sex and vaginal discharge are other common symptoms of cervical cancer.[6]

In this twenty-first century, cervical cancer is a major risk for women worldwide. Cervical cancer is the third most prevalent cancer in Asian women and is still the top cause of cancer-related death in women in low- and middle-income nations.[7] In Asia, approximately 500,000 new cases are identified annually, with a 50% fatality rate. In the United States, approximately 10,370 new cases of cervical cancer are reported annually, with approximately 3,710 fatalities, making it the sixth most prevalent form of cancer among American women.[6] More than 50 million women from Bangladesh are at a high risk of developing cervical cancer, from which there are 17,686 new cases annually. The number of deaths associated with cervical cancer is also alarming since 10,362 deaths occur annually.[8] Most of the women in developing countries such as Bangladesh have never heard of cervical cancer. Even if some women have heard about it, they have poor knowledge about cervical cancer, which would worsen the situation. Therefore, awareness among women by spreading knowledge should be the goal in reducing mortality associated with cervical cancer.[9]

The Government of Bangladesh introduced the visual inspection with acetic acid method for cervical cancer screening, which is convenient and economical and provides an opportunity for immediate treatment in a low-resource setting. Besides, the program offers rapid training for the provider. Colposcopy was referred to screen-positive patients who have been treated with local excision of the cervix by a local ablative method and those who are under precancerous or cancerous conditions. In addition, some women suffering from cervical cancers were also forwarded to government-owned oncology departments to undergo loop electrosurgical excision procedure and thermal ablation for selected cervical intraepithelial neoplasia and "see-and-treat" approach for high-grade diseases combining colposcopy and loop electrosurgical excision procedure.[10]

This study seeks to raise awareness about cervical cancer and give up-to-date information on the frequency and incidence of the disease throughout Bangladesh. Cervical cancer accounts for 6%–29% of all malignancies in women in India.[11] Moreover, 68.6 million women in Pakistan aged >15 years are at risk of cervical cancer. According to current statistics, 5008 women are diagnosed with cervical cancer annually, with 3197 dying from the illness.[12] These Asian neighboring country data concur a healthcare concern among Bangladeshi physicians. According to the International Agency for Research on Cancer, over 50 million Bangladeshi women are at risk of cervical cancer, with 17,686 new cases and 10,362 deaths occurring annually.[13] Conversely, cervical cancer may be effectively treated if detected at an early stage. Cervical cancer caused by HPV genotypes 16 and 18 accounts for approximately 70% of cases. Consequently, screening programs are needed to detect the illness before it becomes an aggressive malignancy.[14]

The results of this study will aid in the early prevention of cancer and the reduction of the suffering and untimely death of women with cervical cancer. This study aimed to evaluate knowledge, awareness, and perceived barriers regarding cervical cancer screening among women with cervical cancer in Bangladesh.

METHODS

Before the study started, a written consent form was obtained from all participants. The NICRH Ethical Research Committee approved the study protocol (Reference no. FO-NICRH/2020/65).

Study design and sampling

This hospital-based survey was conducted at the National Institute of Cancer Research & Hospital (NICRH), which is situated in Dhaka, the capital city of Bangladesh. This is a tertiary care hospital, and people of all cultures usually come here for cancer treatment. The study was conducted from January 2021 to April 2021, and only women were selected as respondents. The respondents were randomly selected by simple random sampling and lottery methods.[15] The sample size was calculated using the method described by Masood *et al*.[16] and an online calculator (http://www.raosoft.com/samplesize.html), with a confidence interval of 95% and a margin of error 5%. This method has a low chance of bias. Although bias is very rare in this method, bias may occur during sample selection. Therefore, an appropriate sample calculation method was used to prevent sample selection bias. For appropriate analysis, achievement of maximum validity, and consideration of allowable error and non-response rate, some additional samples were taken over the calculated sample size. In total, 200 participants were finally selected for this study, and each participant was assigned a unique identification number. The inclusion criteria were as follows: age >18 years, capability to understand English or Bengali, diagnosis of cervical cancer, and willingness to take part in this study. Some participants were excluded from the study because they did not satisfy the above criteria.

Study questionnaire

The written questionnaire was designed by following the previously published articles.[16–20] The whole questionnaire was composed of four segments: (1) demographic characteristics of respondents (6 questions), (2) general knowledge of participants regarding cervical cancer (6 questions), (3) awareness of cervical cancer symptoms (7 questions) and risk factors (9 questions), (4) barriers

toward cervical cancer screening (12 questions). English was used at first for the preparation of the questionnaire; then, for better understanding, it was translated into Bengali by a professional translator. Validation of the questionnaire is a necessary step, which was performed by a panel of experts such as oncologists, clinical pharmacists, social science graduates, and university professors with expertise in relevant fields and healthcare professionals. Few participants were first included in this study to find out if they face problems in understanding the questionnaire; however, any such difficulties were not observed. Different medical terms were elucidated in face-to-face interviews with the participants.

Data collection

Five dedicated pharmacy graduates and physicians were involved as volunteers in data collection. They received a 1-month training course on cervical cancer screening and risk assessment and were trained on handling the research questionnaire. They also took part in various seminars on cervical cancer by the arrangement of different medical institutions. Volunteers followed the above-mentioned steps for data collection. In the first step, the participants were requested to fill out a questionnaire on sociodemographic and anthropometric information. Trained volunteers provided support for those who were unable to fill out the questionnaire and those who face difficulties in understanding it. After the questionnaires were administered to the participants, they received an explanation of the study's purpose and were assured of their confidentiality. Any doubts or questions raised by the participants were clarified by the authors and trained volunteers. Immediately after the questionnaires were completed, they were collected by the volunteers.

Statistical analysis

Stata 13 (StataCorp LP, 4905 Lakeway Drive, College Station, TX 77845, USA) and Microsoft Excel 2013 were used for statistical analysis and data calculation. Microsoft Excel was utilized for data editing and sorting. Later, for descriptive statistics (frequencies, percentages) and first-order analysis (i.e., chi-square tests) Stata was used to import the file. Significant associations between categorical variables were determined with 95% confidence interval. When the *p*-value of these associations was found to be less than 0.05, it was considered statistically significant.

RESULTS

In total, 200 female patients with female cervical cancer participated in the study, with a response rate of 100%. The mean age of the participants was 34.5 years. Table 1 shows the sociodemographic characteristics of the participants. Most (96%) of the participants were married, 0.5% were single, 3% were widowed, and 0.5% were divorced. Most of them (87.5%) were homemakers, 11% were working women, and 1.5% were students. Of the participants, 47% were uneducated and 53% received education.

Most of the respondents (86.5%) were from rural areas, and 13.5% were from urban areas. Only 1.5% had a personal history of cervical cancer, and 15.5% had a family history of cervical cancer.

Their knowledge of cervical cancer was evaluated. All participants said that cervical cancer is rare, 91.5% did not know how to do a cervical self-examination, 61.5% had never heard of cervical cancer, and 74.5% had never heard of screening programs (Table 2).

Table 2 summarizes the participants' responses regarding cervical cancer symptoms and risk factors. The participants reported the following as cervical cancer symptoms: heavier or longer menstrual bleeding and bleeding between periods (N = 200; 100%), strong vaginal discharge with a strong odor (N = 199; 99.5%), pain during sexual intercourse (N = 197; 98.5%), and bleeding after intercourse (N = 197; 98.5%), and bleeding after menopause (N = 193; 96.5%). Responses regarding risk

TABLE 1. Sociodemographic characteristics of the participants

Variable	N (%)
Age in years	
<20	1 (0.5)
20–29	12 (6)
30–39	134 (67)
40–49	36 (18)
50–59	12 (06)
>60	5 (2.5)
Occupation	
Housewife	175 (87.5)
Student	3 (1.5)
Working woman	22 (11)
Educational qualification	
Uneducated	94 (47)
Educated	106 (53)
Marital status	
Single	1 (0.5)
Married	192 (96)
Widow	6 (3)
Divorced	1 (0.5)
Residence	
Urban area	27 (13.5)
Rural area	173 (86.5)
Family monthly income	
Husband	187 (93.5)
Wife	13 (6.5)

TABLE 2. History, women's awareness of symptoms, risk factors of cervical cancer, and barriers toward cervical cancer screening compared between uneducated and educated participants

Statements	Yes	No	*p*
	N (%)	N (%)	
History of cervical cancer			
Is cervical cancer a rare disease?	200 (100)	0 (0)	NA
Family history of cervical cancer	31 (15.5)	169 (84.5)	< 0.05
Do you know how to perform cervical self-examination?	17 (8.5)	183 (91.5)	< 0.05
Have you ever heard about cervical cancer?	77 (38.5)	123 (61.5)	< 0.05
Have you heard about screening programs?	51(25.5)	149 (74.5)	< 0.05
Symptoms of cervical cancer			
Increased vaginal discharge with a strong odor	199 (99.5)	1 (0.5)	
Havier or longer menstrual bleeding	200 (100)	0 (0)	
Pain during sexual intercourse	197 (98.5)	3 (1.5)	
Bleeding after menopause	193 (96.5)	7 (3.5)	
Persistent pelvic or back pain	191 (95.5)	9 (4.5)	
Bleeding after intercourse	197 (98.5)	3 (1.5)	
Bleeding between periods	200 (100)	0 (0)	
Risk factors for cervical cancer			
Have a weakened immune system	193 (96.5)	7 (3.5)	
Take birth control pill for five years or longer	111 (55.5)	89 (44.5)	
Early sexual activity	47 (23.5)	153 (77.5)	
Any sexually transmitted disease	2 (1)	198 (99)	
Poor personal hygiene	190 (95)	10 (5)	
Obesity	131 (65.5)	69 (34.5)	
Genetic factors	60 (30)	140 (70)	
Nutrient deficiency	180 (90)	20 (10)	
Viral factors (HPV and HIV)	140 (70)	60 (60)	
Barriers toward cervical cancer screening			
Embarrassed to tell people about cervical cancer	200 (100)	0 (0)	NA
No idea about what other people think	188 (94)	12 (6)	< 0.05
Fear of hospitals and health facilities	196 (98)	4 (2)	0.057
Stigma following the diagnosis of cancer	170 (85)	30 (15)	< 0.05
Feeling worried about what a doctor might find	200 (100)	0 (0)	NA
Difficulty talking to the doctor	190 (95)	10 (5)	< 0.05
Lack of knowledge	175 (87.5)	25 (12.5)	< 0.05
Fear of physicians and examiners	190 (95)	10 (5)	< 0.05
Afraid of having a Pap test	200 (100)	0 (0)	NA
Busy, no time to do it	196 (98)	4 (2)	0.057
Awareness programs are insufficient	200 (100)	0 (0)	NA
Acceptable to touch the body	200 (100)	0 (0)	NA

Chi-Square Value p <0.05

factors of cervical cancer include having a weakened immune system (N = 193; 96.5%), poor personal hygiene (N = 190; 95%), nutrient deficiency (N = 180; 90%), viral factor (HPV and HIV; N = 140; 70%), obesity (N = 131; 65.5%), taking birth control pill for five years or longer; (N = 111; 55.5%), genetic factors (N = 60; 30%), early sexual activity (N = 47; 23.5%), and any sexually transmitted disease (N = 2; 1%).

Table 2 also summarizes the barriers to cervical cancer screening. For all participants (100%), the barriers to cervical cancer screening were feeling embarrassed to tell people about cervical cancer, worrying about what a doctor might find, fear of having a Pap test, and insufficiency of awareness programs. Other barriers reported were being busy, having no time to do it and fear of hospitals and health facilities (N = 196; 98%), difficulty talking to doctors and fear of physicians and examiners (N = 190; 95%), having no idea about what other people think (N = 188; 94%), lacking knowledge (N = 175; 87.5%), and experiencing stigma following the diagnosis of cancer (N = 170; 85%).

DISCUSSION

Cervical cancer is one of the most common gynecological cancers in women that can be detected early and treated completely at precancerous stages.[17] Moreover, 70% of cervical cancers are caused by HPV (types 16 and 18). They also cause precancerous cervical lesions. Compared with other types, HPV types 16 and 18 are more frequently associated with invasive cervical cancer.[18] It is

considered a major public health trouble for women in Bangladesh.[19]

This hospital-based study aimed to examine women's knowledge, awareness, and perceived obstacles to cervical cancer in Bangladesh. Although the participants had previous experience with cervical cancer, most women lacked knowledge about it, which could be due to socioeconomic, sociocultural, and religious factors.[20] Therefore, they are unaware of screening methods, risk factors, and symptoms that ultimately cause cervical cancers at an advanced stage.[9] Several literature reviews have suggested that the mean age of cervical cancer onset in Bangladesh is lower than in other Asian countries. This young age significantly affects the lack of cervical cancer information and awareness among girls in this nation.[8]

This study found that most of the respondents were from rural areas, where the risk factors were weakened immune system, poor personal hygiene, nutrient deficiency, viral and genetic factors, obesity, and taking birth control pills for a longer period, which is similar to the results of a study conducted in rural and urban areas of North Bengal, India.[21] As cervical cancer symptoms, participants reported heavier or longer menstrual bleeding and bleeding between periods, strong vaginal discharge with a strong odor, pain during sexual intercourse, bleeding after intercourse, and bleeding after menopause similar to the results of a study conducted in Ghana, where qualitative data were collected from patients with cervical cancer in the Volta Region of Ghana.[22]

On the other hand, in our study a significant relationship was observed between educational qualification with history of cervical cancer, like patient's family history, knowledge about how to perform cervical cancer self-examination, knowledge about cervical cancer, knowledge about screening programs and some barriers toward cervical cancer screening such as no idea about what other people think, stigma following the diagnosis of cancer, difficulty talking to the doctor, lack of knowledge, fear of physicians and examiners. Previous study indicated, self-efficacy and accessibility to health care services were better in women who are educated.[23] Several studies conducted in Korea and Zimbabwe showed, those women who gained university-level education were most likely to get screened.[24]

Our findings imply that adequate and socially acceptable cervical cancer awareness initiatives will help in improving knowledge about cervical cancer.[25] Similar studies have shown that South Africa, India, Brazil, and China have high rates of cervical cancer because of a lack of education, unemployment, language unproficiency, communication barrier, and poor preventative strategy.[26] Immunization and screening may prevent cervical cancer with readily accessible technology.[13] As a result, in world regions such as North America and Australia, cervical cancer is not now among the top 20 causes of death. New Zealand and Australia also experience the same scenario. Developed countries have provided a good education in cervical cancer screening and have a high vaccine rate.[27] However, several studies have stated that citizens of developing countries lack confidence in talking about sex, screening problems, and education about cancer.[28] This clarifies why cervical cancer is detected at the last stages in Bangladesh. Bangladeshi women even feel ashamed to talk with doctors about vaginal problems, even with their families. By contrast, Western people are more open-minded, which ultimately helps in detecting cervical cancer at an early stage.[29]

Cervical cancer is most commonly diagnosed in younger women.[30] Women with HPV infection, being sexually active for a more extended period, use of oral contraceptives, cigarette smoking, and genital herpes have a higher risk of acquiring cervical cancer.[31] Better knowledge about cervical cancer is positively associated with women's monthly income and education level because they might share their experiences with other women, such as friends, family, and coworkers.[32,33] Furthermore, unmarried women were less concerned about cervical cancer than others, as married women get spousal support.[19]

Because cervical cancer may be detected early through screening programs, potential hurdles to screening must be identified. Similarly, a study carried out in North America reported that routine cervical cancer screening detected 83% of nonlocalized cancers.[34] Several literature reviews have shown that the most significant obstacle to cervical cancer screening programs is humiliation, fear, and shyness.[33] Lack of awareness, misunderstanding, and lower understanding correlated with education level; mistrust, gossip, and negative experiences in previous meetings with health service providers are significant barriers to cervical cancer screening,[20] which is similar to the study conducted in Nigeria, where the author mentioned a positive attitude toward cervical cancer screening but unsatisfactory uptake rate. The author also added that this uptake is caused by the cost and fear of getting a positive result.[35] This conclusion reflects the social condition where there is a division between afflicted women and the rest of society.[36] If people in the community had adequate counseling, awareness programs, education, and understanding of cervical cancer, the rate of a late diagnosis would be reduced, and individuals diagnosed with cervical cancer would be better managed.[37]

Qayum *et al*. suggested that a lack of cancer information and sociocultural factors that discourage screening may be the root reasons for the low cervical cancer awareness in Bangladesh.[38] Given the increasing cervical

cancer incidence, more awareness campaigns and adequate information delivery may help improve this situation.[37,39] Healthcare experts and the government may jointly work to develop an actionable policy to diagnose and raise awareness among women and the general public.[40] Cervical cancer is usually detected via a Pap test associated with HPV for early detection, which gives better sensitivity.[41] However, self-sampling and at-home tests are also available for cervical cancer screening, although new devices made most of them afraid to perform the screening.[42]

This study was performed at a cancer hospital in the nation's capital because the sociocultural setting did not allow for a broad range of demographic groups. Furthermore, no outside funding was used in this study. Larger-scale studies, with more respondents from various demographic groups and geographic places, can provide a better image of the overall situation, which might lead to the development of cervical cancer awareness initiatives.

CONCLUSIONS

In this study, most female respondents lacked knowledge and awareness of cervical cancer. Factors that may act as barriers to cervical cancer screening include shyness, fear, lack of knowledge, and deficiency of awareness programs. As early detection of this illness with screening can prevent it from becoming an aggressive malignancy, appropriate and socially acceptable awareness programs regarding cervical cancer screening should be arranged, and stakeholders and policymakers should remove all screening barriers.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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Evaluation of Self-Confidence in Women with Chronic Disease

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Evaluation of Self-Confidence in Women with Chronic Disease

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Abstract

Background: Self-confidence, which is an important emotional need in women, affects women's quality of life. This research was conducted to evaluate the self-confidence of women with chronic diseases.

Methods: This study was conducted at the internal medicine clinic of Erzincan Mengücek Gazi Training and Research Hospital in Turkey between August 2019 and June 2020. The sample consisted of 339 female patients with chronic diseases who agreed to participate in this study. Data were collected through face-to-face interviews using information form and the Women's Self-Confidence Scale.

Results: The mean total score of the participants was 136.40 ± 24.92. Scores on the self-confidence scale significantly differed in accordance with the women's age, body mass index, educational status, type of family, place of residence, number of children, self-care, history of smoking, allocation of time-to-herself, activity, perceived health status, presence of chronic obstructive pulmonary disease and other chronic diseases, and information received about the disease ($p < 0.05$).

Conclusions: Women with chronic diseases had a moderate level of self-esteem. Self-confidence is a person's belief that they will perform a particular activity successfully and feel valued. People with high self-confidence are likely to be compatible with themselves through accumulating positive thoughts and feelings about themselves. Therefore, increasing the self-confidence of women with chronic diseases is important.

Keywords: chronic disease, self-confidence, women

INTRODUCTION

Chronic diseases may disrupt an individual's health, psychological, and social life and require long-term treatment and care.[1] As the incidence and prevalence of chronic diseases increase in an aging population, understanding preventive health services, development of diagnosis and treatment methods with technological advancements, and prolonging life expectancy becomes important. The World Health Organization defines chronic diseases as "prolonged and slowly progressing diseases" and chronic conditions as "health problems that require care for several years or decades."[2] Chronic diseases, also known as non-communicable diseases, include cardiovascular diseases (heart attack and stroke), cancers, chronic respiratory diseases (chronic obstructive pulmonary disease (COPD) and asthma), and diabetes.[3] Changes in lifestyle, such as reduced physical activity and changes in eating habits, have increased the prevalence of chronic diseases.[4,5] Approximately two-thirds of the 56 million deaths worldwide are due to non-communicable diseases, such as cardiovascular diseases, cancer, and chronic airway disease. In Turkey, 88% of the deaths in 2017 were due to chronic diseases. Deaths due to chronic diseases are estimated to increase to 52 million in 2030.[6]

Chronic diseases may negatively affect physical, social, and mental health.[1] People with chronic diseases experience problems, such as restricted daily life activities, relationship roles and body image changes, ineffective coping, death anxiety, and decreased self-confidence.[7] In a study conducted on chronic diseases, it is stated that patients' physical activity is low, and their quality of life is negatively affected.[8] Decreased self-confidence and other problems may also affect an individual's adaptation to diseases.[7] Self-confidence is a belief, rather than being an individual characteristic, that an individual will successfully perform daily life activities.[9] Given that individuals are in constant communication with each other in their work and daily lives, the thoughts of individuals regarding trust and self-confidence should not be ignored.[10] Self-confidence, a fundamental element of human psychology, especially in females, is an important emotional requirement. The lack of self-confidence causes problems, such as adverse effects on the quality of life, feelings of worthlessness, and reduced self-esteem. These problems pose obstacles to the management of chronic diseases in individuals.[11,12] Therefore, activities that support the development of self-confidence in individuals with chronic diseases in treatment plans and ensuring that they adapt to these plans are important.

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The increase in chronic disease rates constitutes an important public health problem, especially in women's health. The effects of the social determinants of health, such as gender, race, ethnicity, socioeconomic factors, and access to health services, on women's health differ from those of men. The prevalence of COPD among women has been equal to that among men since 2008 due to increased tobacco usage among women. Given that the prevalence of obesity among patients with diabetes is higher in women than in men and blood pressure control is low in women, diseases, such as cardiovascular and stroke, may cause complications in women.[13] In women with breast cancer, cancer diagnosis, treatment, and metastasis can cause anxiety about the future, depression, anger, disappointment, self-change, fear of losing femininity, and decreased self-confidence. In addition, changes in physical appearance, limitations in daily activities and roles, and the inability to accept the disease may cause changes in patients' self-confidence.[14] This research was conducted to evaluate women's self-confidence with chronic diseases.

METHODS

Approval was obtained from the ethics committee with a date of 07/08/2019 and a number of 08/13. Written permission was obtained from the hospital where this study was conducted. The principles of informed consent, privilege and confidentiality, and the Helsinki Declaration for good clinical practice were fulfilled during data collection for this study. Written informed consent was obtained from the patients participating in the study.

This study was conducted at the internal medicine clinic of a university hospital in Turkey between August 2019 and June 2020 to determine the self-confidence of women with chronic diseases. This hospital was selected because of its large bed capacity in the province where the research was conducted.

The population of this study consisted of women who were treated as inpatients at the hospital's internal medicine clinic during the abovementioned period. The sample of this study comprised 339 female patients who were over 18 years of age, agreed to participate in the study, and had chronic diseases (including comorbid diseases) and were selected from individuals who had been treated as inpatients at the internal medicine clinic since the onset of the study. Participants who were diagnosed with psychiatric disorders and had communication barriers were excluded. The research sample consisted only of people above the age of 18 because participants under 18 years of age in the research require parental consent. Questionnaires were given to the patients by the researcher and filled out by the patients. Only patients with lower literacy were asked the survey questions and subsequently marked by the researcher—the strength of the work *G* was calculated using the Power-3.1.9.2 program. The analysis was applied to 339 people and revealed that the effect size was 0.70710 at $\alpha = 0.05$ level and that the post hoc power of the study was 1.00. The minimum required power value for post hoc analysis was 0.67. In this case, the power was at an acceptable level, and the number of data was sufficient.

The researchers collected data using the face-to-face interview technique, descriptive information form, and the Women's Self-Confidence Scale (WSCS) in-patient rooms. The descriptive data form included age, body mass index (BMI), education and employment status, marital and income status, type of family, place of residence, number of children, practice of self-care, social support, smoking, allocation of time to oneself, performance of regular activities, perceived health status, and questions about chronic illness. The researchers created the questions to investigate whether the specified sociodemographic data would affect self-confidence. The patients verbally replied to questions regarding sociodemographic data.

The scale was developed by Erguntop and Satmis.[9] It is a five-point Likert-type scale comprising 38 items and five subdimensions: satisfaction, social relationships, internal self-confidence, appearance, and performance. In the scale, only items 7, 8, 13, 14, 22, 23, 30, and 31 were scored in reverse. The lowest and highest scores obtained from the scale are 38 and 190, respectively. Given the absence of a cut-off point indicating low or high self-confidence for the scale, evaluation was performed on the basis of whether the mean score was low or high. The same was true for subdimensions. The satisfaction subdimension consists of items for determining a woman's satisfaction with being a woman or her role as a woman. The social relationship subdimension contains items that evaluate women's adaptation to social environments, friendships, and how women feel when communicating with the opposite sex or in social environments. The intrinsic self-confidence subdimension consists of items such as "I trust myself," "I can express myself comfortably," and "I feel inadequate in many aspects." The appearance subdimension consists of items determining how satisfied women are with their appearance. The performance subdimension consists of items such as "I think my capacity is higher than most women," "I can reach my goals," and "I can solve my problems in my own way." The satisfaction, social relationship, inner self-confidence, appearance, and performance, subdimensions had Cronbach's alpha value of 0.77, 0.89, 0.94, 0.78, and 0.98 respectively. The total scale had Cronbach's alpha values of 0.97. In this study, satisfaction, social relations, internal self-confidence, appearance performance subdimensions had Cronbach's alpha value of 0.68, 0.76, 0.84, 0.47, and 0.88. The total scale Cronbach's alpha value was 0.97.

Data were analyzed using SPSS for Windows 25 package. Data analysis was performed to determine frequencies, percentages, minimum and maximum values, mean, and standard deviations. The Mann–Whitney U-test, the Kruskal–Wallis test, independent samples t-test, and ANOVA were used for data analysis. For advanced analysis, the least significant difference test was performed when variances were homogenous, and the Dunnet C test was performed in cases where the data were not homogenous. Here, $p < 0.05$ was considered statistically significant.

RESULTS

Most of the participants in this study were 65 or older, overweight, married, primary school graduates, and unemployed. Most participants stated that they had medium-level income, that their family type is nuclear, and that they live in city centers. Nearly half of the participants did not engage in regular activities (sports, reading, social activities, or listening to music) and had one or three children; the majority of the participants can do their own personal care, receive social support, do not smoke and have no free time. The majority of the participants rated their perceived health status as moderate.

Table 1 shows the participants' scores on the WSCS and its subscales and Table 2 shows that the mean general and other subscale scores of the WSCS scale, excluding the satisfaction subscale, showed statistically significant differences in accordance with age, educational status, place of residence, number of children, and ability to perform personal care ($p < 0.05$). Further analysis revealed that the 19–39 and 40–64 age groups, those who graduated from high school, those living in the city, those with at most three children, and those who could care for their personal care had high mean self-confidence scores.

No statistically significant difference between the mean scores of the WSCS and its subscales was found in accordance with marital status ($p > 0.05$). The WSCS scores, except for the performance subscale scores, did not differ in terms of the participant's employment status ($p > 0.05$). No significant difference was detected in scores on the total WSCS and subscales, except for the satisfaction subscale score regarding income and social support ($p > 0.05$). BMI and family type resulted in statistically significant differences in the scores for the total WSCS and internal self-confidence and appearance subscales ($p < 0.05$). The scores on other subscales were not different ($p > 0.05$). Advanced analyses revealed that the mean confidence score was high in subjects with nuclear families.

Smoking and performing regular activities resulted in significantly different mean scores on the WSCS and its subscales, except for the satisfaction and appearance subscales ($p < 0.05$). Participants who smoked and performed exercises regularly had higher mean WSCS scores than those who did not. The examination of time allocation revealed significant differences in the scores on the total WSCS and the other subscales, except for the appearance and performance subscales. Those who allocated themselves a few days a week had high self-confidence scores. Regarding perceived health status, significant differences were found in the total WSCS and subscale scores ($p < 0.05$). Women with moderate or good perceived health status had higher self-confidence scores than those with poor perceived health.

Table 3 shows that 66.4% of the participants had hypertension, 6.8% had COPD, 11.5% had chronic renal failure, 13.3% had other chronic diseases (epilepsy, Parkinson's, heart failure, and asthma), and 50.1% had diabetes. In this study, 89.1% of the participants with chronic diseases stated that they complied with the treatment, the majority (69.3%) underwent regular health checks, and 50.7% received training from health professionals for their disease.

In consideration of the presence of COPD, the total WSCS and subscale scores were significant except for the satisfaction, social relations, and appearance subscale scores ($p < 0.05$). Those who did not have COPD had high mean self-confidence scores. When the presence of diabetes was examined, the scores on the total WSCS and subscales, except for the appearance subscale, were not significantly different ($p > 0.05$).

In the presence of hypertension and CKD, the total WSCS and the subscale scores were not statistically significantly different ($p > 0.05$). In the presence of other chronic diseases (epilepsy, Parkinson's disease, heart failure, and asthma), the total WSCS and the subscale scores were not statistically significantly different ($p > 0.05$). In terms of treatment adherence and regular follow-up visits, the total WSCS and the subscale scores, except for the satisfaction subscale scores, were statistically significantly different ($p > 0.05$). In terms of obtaining information about the disease, the total WSCS and the subscale scores, except for the satisfaction subscale scores, were statistically significantly different. Participants with high education levels had high self-confidence scores.

TABLE 1. Mean scores of the participants on WSCS and its subscales

WSCS Subscales	Min–Max	Mean ± SD
Satisfaction	2–10	7.81 ± 2.12
Social	8–35	25.06 ± 5.57
Internal Self-Confidence	11–55	39.52 ± 8.18
Appearance	4–20	13.91 ± 3.17
Performance	14–70	50.08 ± 10.61
Total WSCS	42–190	136.40 ± 24.92

TABLE 1. Distribution of the mean and standard deviation (Mean ± SD) total WSCS and subscale scores in accordance with demographic characteristics

Features of the participants	N (%)	Satisfaction	Social relationship	Internal confidence	Appearance	Performance	WSCS total
Age							
19–39	31 (9.1)	8.09 ± 2.34	27.03 ± 5.64	42.48 ± 7.70	14.41 ± 3.62	53.88 ± 10.17	145.87 ± 23.62
40–64	132 (38.9)	8.00 ± 2.02	26.78 ± 5.19	42.23 ± 6.82	14.55 ± 3.17	53.46 ± 9.33	145.05 ± 21.60
65–85	176 (51.9)	7.61 ± 2.15	23.42 ± 5.36	36.97 ± 8.41	13.34 ± 2.99	46.88 ± 10.64	128.24 ± 24.81
p		0.210	**0.000**[a]	**0.000**[a]	**0.002**[a]	**0.000**[a]	**0.000**
BMI							
Underweight	7 (2.1)	7.57 ± 2.07	21.14 ± 6.51	30.28 ± 11.05	12.42 ± 3.10	41.71 ± 12.44	113.14 ± 30.85
Normal weight	102 (30.1)	7.58 ± 2.21	24.20 ± 5.14	37.58 ± 7.84	13.21 ± 3.01	48.81 ± 10.90	131.41 ± 23.91
Overweight	139 (41.0)	7.74 ± 2.13	25.71 ± 5.49	40.56 ± 8.21	14.17 ± 3.26	50.48 ± 10.81	138.69 ± 25.41
Obese	67 (19.8)	8.38 ± 1.85	25.38 ± 5.95	41.01 ± 6.93	14.25 ± 3.04	51.86 ± 8.55	140.91 ± 21.02
Morbid obese	24 (7.1)	7.66 ± 2.31	25.12 ± 5.57	40.29 ± 9.15	14.79 ± 3.27	50.66 ± 11.96	138.54 ± 29.25
p		0.133	0.790	**0.003**[b]	**0.039**[b]	0.180	**0.013**[b]
Education status							
Illiterate	122 (36.0)	7.73 ± 2.13	23.23 ± 5.21	37.42 ± 7.62	13.40 ± 2.77	47.28 ± 9.04	129.09 ± 21.79
Literate	49 (14.5)	7.44 ± 2.44	25.02 ± 5.51	38.91 ± 9.35	13.61 ± 3.67	49.28 ± 11.93	134.28 ± 29.58
Primary school	137 (40.4)	8.04 ± 1.93	25.91 ± 5.36	40.54 ± 7.84	14.43 ± 3.19	51.14 ± 11.07	140.07 ± 24.14
High school	20 (5.9)	7.90 ± 1.86	30.20 ± 5.12	46.55 ± 6.64	15.10 ± 3.30	58.50 ± 7.77	158.25 ± 20.96
University	11 (3.2)	7.27 ± 3.00	25.54 ± 5.53	40.18 ± 7.25	12.18 ± 2.99	56.18 ± 7.52	141.36 ± 21.09
p		0.414	**0.000**[a]	**0.000**[a]	**0.010**[a]	**0.000**[a]	**0.000**[a]
Marital Status							
Married	280 (82.6)	7.86 ± 2.05	25.16 ± 5.53	39.78 ± 8.09	13.99 ± 3.16	50.16 ± 10.62	136.97 ± 24.81
Single	59 (17.4)	7.57 ± 2.41	24.59 ± 5.77	38.32 ± 8.59	13.50 ± 3.20	49.69 ± 40.68	133.69 ± 25.48
p		0.596	0.406	0.133	0.133	0.696	0.271
Employment status							
Employed	22 (6.5)	7.00 ± 2.28	25.18 ± 5.50	40.81 ± 7.22	14.86 ± 2.99	52.81 ± 9.28	140.68 ± 22.10
Unemployed	298 (87.9)	7.89 ± 2.06	25.20 ± 5.61	39.64 ± 8.28	13.90 ± 3.20	50.23 ± 10.63	136.87 ± 25.14
Retired	19 (5.6)	7.42 ± 2.71	22.73 ± 7.71	36.21 ± 7.29	12.94 ± 2.59	44.63 ± 10.41	123.94 ± 21.68
p		0.113	0.174	0.155	0.155	**0.038**[a]	0.063
Income status							
More than expenses	106 (31.3)	7.25 ± 2.39	24.53 ± 5.81	38.43 ± 9.07	13.84 ± 3.15	49.41 ± 10.66	133.49 ± 25.91
Equals expense	219 (64.6)	8.10 ± 1.95	25.35 ± 5.47	39.97 ± 7.27	13.88 ± 3.19	50.31 ± 10.70	137.62 ± 24.65
Less than expenses	14 (4.1)	7.57 ± 1.60	24.50 ± 5.36	40.78 ± 7.84	14.85 ± 3.05	51.57 ± 9.24	139.28 ± 20.83
p		**0.003**[a]	0.435	0.237	0.522	0.672	0.340
Family type							
Nuclear family	216 (63.7)	7.85 ± 2.12	25.53 ± 5.43	40.31 ± 7.85	14.20 ± 3.25	50.91 ± 10.10	138.82 ± 24.14
Extended family	97 (28.6)	7.76 ± 2.07	24.18 ± 5.57	38.50 ± 8.05	13.59 ± 2.92	48.85 ± 11.23	132.90 ± 24.78
Separated family	26 (7.7)	7.65 ± 2.38	23.38 ± 6.42	36.84 ± 10.48	12.65 ± 3.12	47.76 ± 11.99	129.30 ± 29.57
p		0.866	0.114	**0.043**[a]	**0.032**[a]	0.145	**0.048**[a]

TABLE 1. Continued

Features of the participants	N (%)	Satisfaction	Social relationship	Internal confidence	Appearance	Performance	WSCS total
Place of Residence							
Village	82 (24.2)	7.62 ± 2.01	23.51 ± 4.87	37.60 ± 7.52	13.06 ± 2.79	47.30 ± 9.95	129.10 ± 21.91
Town	77 (22.7)	7.58 ± 2.27	23.84 ± 5.46	37.62 ± 8.59	13.55 ± 3.02	48.51 ± 10.88	131.12 ± 26.23
City	180 (53.1)	8.00 ± 2.10	26.28 ± 5.66	41.21 ± 7.97	14.45 ± 3.30	52.02 ± 10.46	141.97 ± 24.41
p		0.229	**0.000**[a]	**0.000**[a]	**0.002**[a]	**0.001**[a]	**0.000**[a]
Number of children							
1–3	150 (44.2)	7.94 ± 2.03	25.92 ± 5.61	40.66 ± 8.45	14.22 ± 3.54	51.48 ± 10.95	140.22 ± 26.20
4–6	129 (38.1)	7.72 ± 2.16	24.19 ± 5.29	38.01 ± 8.07	13.74 ± 2.86	48.33 ± 10.13	132.00 ± 23.62
7–12	23 (6.8)	7.69 ± 2.26	23.08 ± 6.14	38.13 ± 7.87	12.39 ± 2.38	47.95 ± 10.88	129.26 ± 25.26
p		0.655	**0.009**[a]	**0.022**[a]	**0.033**[a]	**0.033**[a]	**0.010**[a]
Able to make personal care							
Yes	211 (62.2)	7.93 ± 2.15	26.54 ± 5.31	42.02 ± 7.59	14.46 ± 3.15	52.12 ± 10.47	143.09 ± 24.03
No	62 (18.3)	7.37 ± 2.08	22.51 ± 4.93	34.79 ± 8.40	13.12 ± 2.84	47.08 ± 10.91	124.88 ± 24.25
Partially	66 (19.5)	7.83 ± 2.03	22.72 ± 5.35	35.98 ± 6.46	12.87 ± 3.17	46.37 ± 9.15	125.80 ± 20.63
p		0.181	**0.000**[a]	**0.000**[a]	**0.000**[a]	**0.000**[a]	**0.000**[a]
Social support							
Yes	290 (85.5)	7.96 ± 2.06	25.15 ± 5.50	39.82 ± 7.96	13.93 ± 3.11	50.34 ± 10.49	137.22 ± 24.37
No	24 (7.1)	6.5 ± 2.24	25.33 ± 6.59	38.08 ± 10.56	13.79 ± 3.86	48.16 ± 12.94	131.87 ± 32.53
Sometimes	25 (7.4)	7.36 ± 2.23	23.68 ± 5.41	37.52 ± 8.09	13.72 ± 3.24	48.92 ± 9.80	131.20 ± 22.83
p		**0.002**[B]	0.367	0.329	0.723	0.509	0.280
Smoking							
Yes	34 (10.0)	7.17 ± 2.49	26.85 ± 6.82	44.29 ± 7.92	14.14 ± 3.65	54.20 ± 11.21	146.67 ± 26.07
No	305 (90.0)	7.88 ± 2.07	24.86 ± 5.39	38.99 ± 8.05	13.88 ± 3.12	49.62 ± 10.46	135.25 ± 24.57
p		0.065	**0.048**[c]	**0.000**[c]	0.649	**0.017**[c]	**0.011**[c]
Time allocation for herself							
Never	109 (32.2)	7.46 ± 2.10	24.31 ± 5.55	37.78 ± 8.72	13.87 ± 3.10	49.24 ± 11.21	132.68 ± 26.22
A few times a month	59 (17.4)	7.98 ± 2.00	24.45±5.22	39.35 ± 7.37	13.62 ± 2.91	49.77 ± 8.69	135.20 ± 19.75
Once a week	72 (21.2)	7.61 ± 2.03	24.90 ± 5.43	39.76 ± 6.75	13.63 ± 3.24	48.87 ± 8.46	134.79 ± 21.50
A few times a week	99 (29.2)	8.24 ± 2.22	26.36 ± 5.75	41.37 ± 8.68	14.32 ± 3.34	52.07 ± 12.15	142.37 ± 27.64
p		**0.046**[a]	**0.043**[a]	**0.018**[a]	0.444	0.163	**0.035**[a]
Performing activities							
Yes	91 (26.8)	7.89 ± 2.15	27.01 ± 5.42	42.34 ± 7.37	14.19 ± 3.61	53.56 ± 10.57	145.00 ± 23.38
No	248 (73.2)	7.78 ± 2.11	24.34 ± 5.47	38.49 ± 8.24	13.80 ± 2.99	48.81 ± 10.36	133.24 ± 24.77
p		0.691	**0.000**[c]	**0.000**[c]	0.315	**0.000**[c]	**0.000**[c]
Perceived status of health							
Bad	130 (38.3)	7.09 ± 2.51	23.56 ± 5.84	37.67 ± 9.19	13.51 ± 3.25	47.61 ± 11.32	129.46 ± 26.89
Worse	154 (45.4)	8.04 ± 1.72	25.65 ± 5.21	40.35 ± 7.46	13.94 ± 3.01	51.21 ± 10.25	139.21 ± 23.32
Good	55 (6.3)	8.87 ± 1.45	26.94 ± 5.11	41.58 ± 6.75	14.76 ± 3.31	52.76 ± 8.72	144.92 ± 20.17
p		**0.000**[a]	**0.000**[a]	**0.003**[a]	**0.049**[a]	**0.002**[a]	**0.000**[a]

Bold values: Results are significant if $p < 0.05$

[a]One-way analysis of variance (ANOVA); [b] Kruskal wallis test

TABLE 2. Distribution of total WSCS and subscale scores in accordance with the chronic disease characteristics of the participants (Mean SD)

Features of the participants	N (%)	Satisfaction	Social relations	Internal self-confidence	Appearance	Performance	WSCS total
COPD							
Yes	23 (6.8)	7.56 ± 2.35	23.26 ± 5.42	34.60 ± 8.22	13.34 ± 3.58	43.91 ± 11.22	122.69 ± 26.15
No	316 (93.2)	7.83 ± 2.10	25.19 ± 5.57	39.88 ± 8.08	13.95 ± 3.14	50.53 ± 10.44	137.39 ± 24.57
p		0.608	0.099	**0.004**[a]	0.466	**0.005**[a]	**0.011**[a]
Hypertension							
Yes	225 (66.4)	7.80 ± 2.09	25.10 ± 5.42	39.35 ± 8.00	14.06 ± 3.07	49.91 ± 10.29	136.23 ± 24.16
No	114 (33.6)	7.84 ± 2.19	24.98 ± 5.89	39.86 ± 8.56	13.61 ± 3.34	50.42 ± 11.26	136.73 ± 26.46
p		0.720	0.991	0.455	0.283	0.699	0.735
Diabetes							
Yes	170 (50.1)	7.55 ± 2.28	24.54 ± 5.60	39.48 ± 8.16	13.51 ± 3.08	50.05 ± 10.43	135.16 ± 24.69
No	169 (49.9)	8.07 ± 1.92	25.57 ± 5.51	39.56 ± 8.24	14.30 ± 3.21	50.11 ± 10.83	137.64 ± 25.16
p		0.062	0.110	0.961	**0.020**[a]	0.961	0.540
CKD							
Yes	39 (11.5)	8.12 ± 1.48	25.43 ± 4.98	38.79 ± 7.22	14.00 ± 3.20	48.02 ± 9.95	134.38 ± 22.15
No	300 (88.5)	7.77 ± 2.19	25.01 ± 5.65	39.62 ± 8.31	13.90 ± 3.17	50.35 ± 10.68	136.66 ± 25.28
p		0.194	0.657	0.553	0.853	0.198	0.592
Other chronic diseases							
Yes	45 (13.3)	7.80 ± 1.94	23.93 ± 5.91	36.64 ± 9.58	13.48 ± 3.21	47.75 ± 11.94	129.62 ± 28.12
No	294 (86.7)	7.81 ± 2.15	25.23 ± 5.51	39.96 ± 7.88	13.97 ± 3.16	50.44 ± 10.37	137.43 ± 24.28
p		0.962	0.145	**0.031**[b]	0.338	0.114	0.050
Treatment adherence							
Yes	302 (89.1)	7.99 ± 1.94	25.14 ± 5.33	39.59 ± 7.88	13.97 ± 3.10	49.99 ± 10.36	136.69 ± 23.95
No	37 (10.9)	6.37 ± 2.91	24.40 ± 7.30	38.94 ± 10.48	13.43 ± 3.72	50.83 ± 12.62	134.00 ± 32.03
p		**0.001**[a]	0.833	0.984	0.503	0.437	0.986
Regular health checks							
Yes	235 (69.3)	7.99 ± 2.00	25.34 ± 5.39	39.79 ± 8.42	14.10 ± 3.23	50.28 ± 10.91	137.51 ± 25.62
No	104 (30.7)	7.41 ± 2.33	24.42 ± 5.94	38.93 ± 7.63	13.48 ± 3.00	49.62 ± 9.95	133.87 ± 23.18
p		**0.030**[c]	0.161	0.374	0.097	0.596	0.215
Education status regarding the disease							
	172 (50.7)	7.81 ± 2.11	25.95 ± 5.40	40.64 ± 7.89	14.36 ± 3.29	51.33 ± 10.22	140.11 ± 24.34
No	167 (49.3)	7.81 ± 2.13	24.13 ± 5.61	38.37 ± 8.35	13.44 ± 2.97	48.80 ± 10.88	132.57 ± 25.01
p		0.963	**0.003**[a]	**0.005**[a]	**0.008**[a]	**0.014**[a]	**0.004**[a]

Bold values: Results are significant if $p < 0.05$

[a]Mann–Whitney U-test [b] Independent samples t-test.

DISCUSSION

Individuals with chronic diseases experience many negative emotions as they cope with disease symptoms, treatment limitations, and concerns about the future. These emotions may affect their physical, psychological, and social health. Self-confidence, an effective cognitive–emotional tool for creating psychological well-being, is an important concept for the quality of life of individuals with chronic diseases.[5] The mean self-confidence score of women with chronic diseases was 136.40 ± 24.92, indicating moderate self-confidence. The lowest and highest scores that can be obtained on the scale were 38 and 190, respectively. Given the lack of a cut-off point indicating low or high self-confidence on the scale, evaluation was performed in accordance with the value of the mean score (low or high). The mean self-confidence score of women in this study was consistent with that in previous research.[15] Self-esteem, a concept related to self-confidence, is defined as the degree to which an individual considers herself capable and valuable.[9] People with high self-esteem feel self-confident, have positive feelings about themselves, believe in their competence, and adapt to different situations.[16] A study on women with breast cancer demonstrated that most women have high self-esteem and self-confidence.[14,17] Another work demonstrated that the female gender was positively related to self-confidence.[18]

This study found that self-confidence decreased with increasing age, and the self-confidence levels of the 65–85-year-old group were higher than those of other age groups. Similar results were also found in previous studies.[19] As women with chronic diseases age, their physical, psychological, and cognitive functions decline. As a result, their self-esteem decreases due to the change in their productivity and roles in life.

A relationship was found between the BMI of the participants and self-confidence and the self-confidence of women with first-degree obesity. The results were consistent with the findings obtained in a previous work that reported that obese individuals have high self-confidence.[15] A relationship was found between educational status and self-confidence, given that high school graduates had high average self-confidence scores. Previous studies have discovered that self-confidence increases with academic level.[20] A high educational level enables an individual to develop methods for coping with stressors, take an active role in disease management, have a high socioeconomic status, and have a positive view of life. These characteristics are thought to lead to an increase in self-confidence.

A relationship was found between the place of residence and self-confidence, and those residing in cities had high average self-confidence scores. This finding was consistent with previous results.[15,21,22] Women living in cities have opportunities to participate in social activities, such as exhibitions and courses that affect their development, and have easy access to institutions that provide health services. These opportunities have a positive effect on their self-esteem. A relationship was observed between family type and self-confidence. Specifically, women with nuclear families had a high mean self-confidence score.

Similar to previous studies, a relationship was observed between smoking and women's self-esteem; with women who smoke have high self-confidence.[15,23] In contrast to the present work, previous research found that individuals with low self-esteem tend to smoke.[24] Smokers may have high self-esteem because they think that they manage their distress and emotions by smoking.

The health status perceived by the participants and their self-confidence were related. Those who perceived their health as good had high mean self-confidence scores. Other studies also showed that in women, perceived health status had a positive effect on self-esteem.[25,26] A study on nursing students, the majority of whom were female, found that perceived health status affected self-confidence and that individuals with a high perceived health status had high self-confidence.[27]

The participants' ability to allocate time to themselves and perform regular activities was related to their self-confidence. The mean self-confidence score of those who allocated time to themselves for a few days a week and performed regular activities was high. These findings were similar to previous results, which showed that those who conducted regular activities had significantly high mean self-confidence scores.[15] The participation of individuals in physical activities and self-confidence are positively related, and in female students, low physical activity levels negatively affected self-confidence.[28] Many studies have found that students who frequently participated in social activities had significantly higher self-confidence levels than those who did not[21,22] Previous research has emphasized that social and emotional development can be individuals' primary motivation source.[29] Women who devote time to themselves and regularly engage in activities experience positive effects on their self-esteem because they feel good, think positively, have an improved ability to cope with stress, manage chronic diseases, and are at peace with their bodies. In addition, individuals with low self-esteem may fail to maintain or establish social relationships because they may not be likely to seek social activities.

The presence of COPD was related to the self-confidence of the participants. Specifically, women with COPD had low self-confidence scores. Shortness of breath, which is very common in patients with COPD, was the most important symptom restricting the individual's performance status and daily life activities. Physiological

and psychological symptoms may cause distancing from society, social isolation, fatigue, malaise, and lack of self-confidence.[30] A study found that individuals with COPD who used coping strategies for their disease had high self-confidence.[31] Using oxygen for a long time, limitations on daily life activities, high hospitalization frequencies, not using coping mechanisms, social interaction, and decreased quality of life may cause the individual's self-confidence loss.

The findings showed that the training status of the participants about their chronic illness was related to their self-confidence. Participants who received training had high self-confidence. Individuals with chronic diseases had a negative view of their self and social identity due to long-term hospitalization, treatment and dependence on various drugs or devices, reductions in their ability to control the period they live in and the future, psychiatric comorbidities, decreased social relationships, and physical losses due to diseases.[32] These conditions decrease the self-confidence of individuals. Among health professionals, nurses contribute to the adaptation of patients to their new conditions, the protection of the self-esteem of individuals, and the development of self-confidence by educating individuals with chronic diseases on disease adaptation, hospitalization, and treatment and methods for coping with stress.

This study has the following limitations: It was conducted in a single center, and its sample consisted only of women with limited sociodemographic characteristics and an unequal number of chronic diseases. Multicentered research includes both genders in the sample group, has many samples, and takes sociodemographic characteristics comprehensively.

CONCLUSIONS

The findings of this work showed that chronically ill women had moderate self-esteem. Their age, BMI, educational status, type of family, place of residence, number of children, ability to perform self-care, smoking, devoting time to themselves, doing activities, perceived health status, having COPD and other chronic diseases, and being educated about their disease affected their level of self-confidence. As health professionals, nurses are recommended to plan the nursing process by evaluating the self-confidence of healthy/sick women, establishing self-confidence-building methods and healthy communication, and increasing the frequency of providing social support systems and training to increase the self-confidence level of women. Such an approach will help healthcare institutions give importance not only to medical treatment but also to psychosocial support programs so that individuals can take responsibility for developing positive attitudes and behaviors toward their health and self-confidence.

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CONFLICT OF INTEREST

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Related Factors with Self-Management Behaviors among Patients with Predialysis Chronic Kidney Disease: A Multicenter Study in Myanmar

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Related Factors with Self-Management Behaviors among Patients with Predialysis Chronic Kidney Disease: A Multicenter Study in Myanmar

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Abstract

Background: Self-management behavior is a key to managing patients with predialysis chronic kidney disease (CKD) and is effective in slowing disease progression in impoverished Burmese patients with CKD. This study aimed to outline the association of personal and environmental factors with the self-management behaviors of people with predialysis CKD.

Methods: Using convenience sampling, this cross-sectional study included 84 individuals with predialysis CKD from two private hospitals in Myanmar. The interviewer-administered questionnaire included demographic information, the Health Literacy Short Form-12, the CKD knowledge questionnaire, the self-efficacy questionnaire, the Multidimensional Scale of Perceived Social Support, and the self-management behavior questionnaire. This study analyzed the data using descriptive statistics, Pearson's correlation coefficients, Spearman's rho correlation, and Chi-square tests.

Results: The results revealed that participants had moderate health literacy (26.12 ± 7.51), CKD knowledge (10.10 ± 3.76), and perceived self-efficacy levels (30.58 ± 10.28), a high social support level (67.33 ± 8.54), and a moderate self-management behavior level (74.20 ± 7.80). Health literacy (r = 0.40, p < 0.01), CKD knowledge (r = 0.62, p < 0.01), perceived self-efficacy (r = 0.62, p < 0.01), and social support (r = 0.44, p < 0.01) were related to self-management behaviors.

Conclusions: The results indicated that enhanced health literacy, CKD knowledge, self-efficacy, and social support could support the self-management behaviors of individuals with predialysis CKD.

Keywords: chronic kidney disease, health literacy, Myanmar, self-efficacy, self-management

INTRODUCTION

Chronic kidney disease (CKD) has emerged as a substantial global health challenge. The prevalence of CKD affected approximately 13.4% of the global population in 2015.[1] Regional data indicates a projected increase in CKD prevalence rate at approximately 16.7% of the adult population in the United States by the year 2030.[2] Meanwhile, the prevalence of CKD was notably high in South Asian countries, which affect 1–4 out of every ten individuals between 2009 and 2016.[3] Additionally, the prevalence rate of CKD reached a staggering figure in 2017, affecting over 69 billion people in the South East Asia region.[4]

Furthermore, CKD imposes a significant burden on global mortality and morbidity. Kidney failure alone accounted for 1.2 million deaths globally in 2015,[5] positioning it as the twelfth leading cause of global death in 2017.[6] The impact of CKD is not limited to mortality, as it resulted in approximately 35.8 million disability-adjusted life years globally in 2017.[4]

The 2015 national survey on the population aged ≥20 in Myanmar, a country in Southeast Asia, reported that approximately 3.6 million (10.5%) of Myanmar's population had kidney disease problems.[6] Additionally, the incidence had skyrocketed from 4000 to approximately 7000 individuals in Mandalay, a tertiary hospital, from 2012 to 2016.[7] Myanmar rated kidney disease as the eleventh leading cause of death, and 3.05% of total deaths belonged to kidney-related problems in 2018.[8]

CKD-related complications financially impact the healthcare system, even in wealthy countries such as the United States of America.[9] Only one-tenth of patients with end-stage kidney disease (ESKD) can afford appropriate renal replacement therapy (RRT), and most people face financial issues in developing countries, such as Myanmar.[10] The costs of CKD management increase accordingly with its stage progression, and RRT is the most expensive treatment for CKD, which becomes the only option after ESKD progression. Therefore, appropriate management should be considered during the predialysis stages of CKD to reduce the burden of ESKD.

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CKD is a progressive and irreversible chronic disease in which self-management has been crucial to properly managing CKD in the early stages. Bandura defined self-management as the behaviors individuals continuously attempt to regulate and contribute to maintain good health in their daily lives.[11] The social cognitive theory states that behavioral outcomes arise from the reciprocal interaction of personal and environmental factors.[12] Personal factors might be any aspects of cognitive, personality, or demographic factors,[13] in which knowledge of health risks and benefits and perceived self-efficacy are the core determinants of successful change in health behaviors.[14] Health literacy is a remarkable predictor of self-management behaviors.[15] Environmental factors are external influences that affect individuals physically or socially,[13] and performing health behaviors requires social systems that impact individuals' health.[14] The fundamental concepts of social cognitive theory and literature review indicated that personal factors (age, gender, marital status, education, CKD duration, health literacy, CKD knowledge, and perceived self-efficacy) and environmental factors (social support) need to be considered for self-management behaviors in this study.

The literature revealed the association of higher performance of self-management behavior with some demographic factors, such as younger people, higher education levels, and longer disease duration.[16] Additionally, gender[17] and marital status[15,18] were associated with CKD patients' self-management behaviors. Self-management behavior revealed significant associations with various factors in different CKD stages. It was significantly associated with health literacy[19], CKD knowledge,[20,21] and social support in the predialysis population.[21] Self-management behavior was correlated with health literacy,[22,23] CKD knowledge,[17,24] and social support in patients on hemodialysis.[17,24–26] Moreover, self-management behavior exhibited correlations with health literacy,[15] CKD knowledge,[19] and social support[15] across all stages of CKD.

However, the study on those significant factors remained under-identified in patients with predialysis CKD. Additionally, patients on hemodialysis in Myanmar reported an inadequate self-management level.[27] Therefore, this study aimed to outline the relationships between personal and environmental factors and self-management behaviors in patients with predialysis CKD in Myanmar.

METHODS

The Ethical Review Committee on Human Research, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand, and the Institutional Review Board from Medical and Alliance Universities, Ministry of Education, Myanmar, approved this study. The researcher explained the study's objectives, expected risks, and benefits. The informed consent form was distributed to participants to sign before beginning the data collection. Moreover, participants had the right to withdraw from the study at any time without any impact on the medical treatment they had received. All data were kept confidential and anonymous.

This cross-sectional descriptive correlational study of patients with predialysis CKD was conducted from December 2021 to February 2022 in outpatient departments of two private hospitals: City Private Hospital in Mandalay, Myanmar, and Bahosi Private Hospital in Yangon, Myanmar.

Participants were individuals diagnosed with CKD for over three months with an estimated glomerular filtration rate (eGFR) of 15–90 ml/min/1.73 m^2 (predialysis stages 2–4). Other inclusion criteria were that participants should be aged ≥18 years, able to read and write in the Myanmar language, have intact cognitive status, and agree to participate in the study. This study used the G*Power program to calculate the required minimum sample size. A bivariate correlation included a power of 0.85, a significance alpha of 0.05, and an effect size of 0.33 based on the previous study by Chen *et al*.[15] The minimum sample size was 79. Including an attrition rate of 10%,[28] this study planned to recruit 87 participants. However, three subjects aged approximately 90 years were considered outliers for needing assistance when answering the questionnaires. Therefore, the total participants were 84.

The Institutional Review Board, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand (ID 2855) and the Institutional Review Board from Medical and Alliance Universities, Ministry of Education, Myanmar approved this study (MOE-IRB, 2021/Research/No.090). Then, the researcher obtained permission from the directors of two private hospitals: City Private Hospital in Mandalay, Myanmar, and Bahosi Private Hospital in Yangon, Myanmar. The researcher asked permission and coordinated with outpatient department nurses in each setting, which met the inclusion criteria. Eligible participants for predialysis CKD stages 2–4 were selected according to the doctor's notes and eGFR on medical record books. Researchers approached all potential participants. Participants who were willing to participate in the study were then explained about the information sheet, signed an informed consent form, and interviewed in the waiting room. Each participant completed the interview for approximately 30 min.

This study used the Health Literacy Short Form-12 (HLS-SF12),[29] the CKD knowledge,[20] the CKD self-efficacy,[30] the Multidimensional Scale of Perceived Social Support (MSPSS),[31] and the CKD self-management behaviors questionnaires[20] in English versions. These instruments

were translated from English into Burmese versions by the recommendation of Maneesriwongul and Dixon to ensure cross-cultural comparisons.[32] The process of forward translation, backward translation, and comparison between original and translated English versions included three bilingual experts.

Subsequently, five experts validated the Burmese questionnaires' content validity index (CVI). Twenty participants (20% of the main study) participated in the pilot study of the targeted population to assess the appropriateness or comprehension of participants with similar characteristics to the targeted population at the Royal Private Hospital, Yangon, Myanmar, for the questionnaire reliability.[33] The results revealed the acceptability of all questionnaires' validity and Cronbach's alpha.

The researcher developed this tool, which consisted of age, gender, religion, marital status, education level, monthly income, comorbidities, and CKD duration.

Duong *et al*. developed HLS-SF12 in 2017 to screen three health domains of health literacy (health care, disease prevention, and health promotion).[29] The Cronbach's alpha of the original instrument was 0.85. The tool comprises 12 questions, scored from 1 (very difficult) to 4 (very easy). The possible scores range from 12 to 48 points, with 12–24, 25–36, and 37–48 points indicating low, moderate, and high scores, respectively. The original English version was translated to the Myanmar version with the validation of the content validity of 1.0 and Cronbach's alpha of 0.937.

Moktan *et al*.[20] developed a CKD knowledge questionnaire for the predialysis CKD population, which was then translated and adapted under the developer's permission. The content validity of the original version was 0.99, with Kuder-Richardson of 0.866. The instrument of this study includes 18 items with the responses "yes," "no," "unsure," and "unknown." The correct response was one point, and the incorrect answer was zero. The score ranges from 0 to 18, with 0–9, 10–13, and 14–18 points indicating low, moderate, and high scores, respectively. The CVI of this questionnaire was 0.98, with Cronbach's alpha of 0.807.

Curtin *et al*. developed a Self-Efficacy questionnaire in 2008 to measure participants' beliefs and confidence in early CKD stages with Cronbach's alpha of 0.92.[30] Moktan *et al*. modified this instrument in 2019, containing 12 items with a 5-point Likert scale with Cronbach's alpha of 0.887.[20] This study obtained permission from the original developers to modify the scale by deleting one item. Thus, this study only used 11 items. The possible scores range from 11 to 55, with 11–27, 28–41, and 42–55 points indicating low, moderate, and high scores, respectively. The CVI was 1.0, with Cronbach's alpha of 0.937.

Zimet *et al*. developed MSPSS in 1988 to evaluate three dimensions of social support: significant others, family, and friends.[31] Cronbach's alpha of the original version was 0.88. The tool is composed of 12 questions with a 7-point Likert scale. The possible responses range from 12 to 84, with 12–42, 43–63, and 64–84 points indicating low, moderate, and high scores, respectively. The CVI was 1.0, with Cronbach's alpha of 0.902.

Moktan *et al*. developed a Self-management behaviors questionnaire in 2019 to assess three dimensions of self-management behaviors: engagement in activities/treatment guidelines, symptom management, and the use of recommended medical therapies.[20] The CVI was 0.96, with Cronbach's alpha of the original version of 0.719. The questionnaire is composed of 28 items with a 4-point rating scale. The possible responses range from 28 to 112, with 28–56, 57–84, and 85–112 points indicating low, moderate, and high scores, respectively. The CVI of this instrument was 1.0, with Cronbach's alpha of 0.746.

A statistical software package was used to enter the data. The data were checked for accuracy, consistency, completeness, and outliers. The test of normality excluded three outliers. Descriptive statistics, including percentage, mean (M), and standard deviation (SD), were calculated for demographic characteristics (age, gender, education, marital status, and CKD duration) and levels of health literacy, CKD knowledge, perceived self-efficacy, social support, and self-management behaviors.

The Shapiro–Wilk test, skewness, and kurtosis were run before the inferential analysis. Pearson's correlation coefficient was used for continuous data that met normality (age, health literacy, CKD knowledge, self-efficacy, and social support) on self-management behavior. Nonnormality data, such as CKD duration, was analyzed by the Spearman correlation, while the Chi-square analysis was applied to examine the relationship between categorical variables (gender, marital status, and education) and self-management behavior. This study categorized the education level of participants as high education for a bachelor's degree and low education for at least high school.[16] *P*-values of <0.05 were considered statistically significant.

RESULTS

The survey included 84 participants after cleaning the data and checking the completeness and outliers. The age of participants ranged from 20 to 87 years, with an average of 57.98 ± 13.61 years. Additionally, 90.5% of the participants were Buddhists, 76.2% were married, 79.8% had education not higher than high school education, 75% had an average income of <300,000 MMK per month (approximately 150 USD; 1 USD = 1900 MMK), 91.7% had been suffering comorbidities, including hypertension

(85.7%) and diabetes (54.8%), and approximately 90.5% did not believe in the unconventional therapy (Table 1).

The scores of the participants were calculated for percentages, and the scores were divided into low (<50%), moderate (51–75%), and high levels (>75%) to describe the levels of health literacy, CKD knowledge, self-efficacy, perceiving social support, and self-management behaviors.[20]

Moreover, the participants' overall health literacy and CKD knowledge levels were moderate (54.41%, 26.12 ± 7.51; 56.08%, 10.10 ± 3.76, respectively). In this study, most Burmese people with predialysis CKD had a moderate self-efficacy level (55.61%, 30.58 ± 10.28). In contrast, the participants reported a high perceived social support level (80.16%, 67.33 ± 8.54). Finally, the participants' mean score of self-management behaviors was moderate (66.25%,74.20 ± 7.80), as shown in Table 2.

Gender, marital status, education status, and self-management behaviors (Table 3) among people with predialysis CKD demonstrated no association in this study. The correlational analysis revealed that age and CKD duration demonstrated no association with self-management behaviors (Table 4). However, health literacy (r = 0.396), CKD knowledge (r = 0.621), perceived self-efficacy (r = 0.620), and perceived social support (r = 0.435) demonstrated significant relationships with self-management behaviors at the level of 0.01 (Table 4).

TABLE 1. Sociodemographic characteristics of patients with predialysis CKD (N = 84)

Characteristics	N (%)
Age in years	
< 41	10 (11.9)
41 – 60	34 (40.5)
> 60	40 (47.6)
(Mean = 57.98, SD = 13.61, Min = 20, Max = 87)	
Gender	
Male	39 (46.4)
Female	45 (53.6)
Religion	
Buddhist	76 (90.5)
Islam	6 (7.1)
Hindu	2 (2.4)
Marital Status	
Single	12 (14.3)
Married	64 (76.2)
Widow/widower/separated	8 (9.5)
Education	
No education	6 (7.1)
Primary school	20 (23.8)
Middle school	20 (23.8)
High school	21 (25.0)
Bachelor degree	17 (20.2)
Monthly income	
<300000 MMK	63 (75.0)
300000–500000 MMK	14 (16.7)
>500000 MMK	7 (8.3)
Comorbidities	
No	7 (8.3)
Yes (can answer more than one)	77 (91.7)
Hypertension	72 (85.7)
Diabetes	46 (54.8)
Heart disease	12 (14.3)
Dyslipidemia	7 (8.3)
Stroke	3 (3.6)
Others (asthma, bilateral renal stones, urinary tract infection, etc.)	10 (11.9)
CKD stage	
Stage 2	11 (13.1)
Stage 3A	10 (11.9)
Stage 3B	19 (22.6)
Stage 4	44 (52.4)
Duration of CKD diagnosed	
< 6 months	33 (39.3)
6 months to 1 year	20 (23.8)
1–3 years	16 (19.0)
3–5 years	12 (14.3)
>7 years	3 (3.6)
(Mean = 21.42, SD = 26.33, Min = 3.5 months, Max = 120 months)	
Self-management experience of CKD	
Least	43 (51.2)
Less	26 (31.0)
More	12 (14.3)
Most	3 (3.6)
Belief in treatment with unconventional therapy	
Least	55 (65.5)
Less	21 (25.0)
More	7 (8.3)
Most	1 (1.2)
Treatment was taken at	
Private hospital only	71 (84.5)
Both private and government hospitals	13 (15.5)

TABLE 2. Descriptive statistics of health literacy, CKD knowledge, self-efficacy, social support, and self-management behaviors in patients with predialysis CKD (N = 84)

Variables	Mean	SD	%	Interpretation
Health literacy	26.12	7.51	54.41%	Moderate
CKD knowledge	10.10	3.76	56.08%	Moderate
Self-efficacy	30.58	10.28	55.61%	Moderate
Social support	67.33	8.54	80.16%	High
Self-management behaviors	74.20	7.80	66.25%	Moderate

TABLE 3. Association of gender, marital status, and educational status with self-management behaviors in patients with predialysis CKD (N = 84) using a Chi-square table

Variables	Self-Management Behaviors				*p*
	Low and Moderate (28 – 84)		High (85 – 112)		
	N	%	N	%	
Gender					
Male	37	92.5	3	7.5	0.183
Female	39	83.0	8	17.0	
Marital status					
Married	56	84.8	10	15.2	0.212
Unmarried (single/widow/widower/separated)	20	95.2	1	4.8	
Education level					
Low education	63	90.0	7	10.0	0.132
High education	13	76.5	4	23.5	

TABLE 4. Association of age, CKD duration, health literacy, CKD knowledge, self-efficacy, and social support with self-management behaviors in patients with predialysis CKD using Pearson's or Spearman correlation (N = 84)

Variables	1	2	3	4	5	6	7
1. Age	1						
2. CKD Duration	0.057	1					
3. Health literacy	−0.287**	−0.007	1				
4. CKD knowledge	−0.155	0.206	0.565**	1			
5. Self-efficacy	−0.247*	0.139	0.720**	0.698**	1		
6. Social support	−0.072	0.133	0.206	0.426**	0.366**	1	
7. Self-management behaviors	−0.062	0.195	0.396**	0.621**	0.620**	0.435**	1

**$p < 0.01$, *$p < 0.05$

DISCUSSION

This study aimed to analyze factors associated with self-management behaviors in the predialysis CKD population. The study results revealed that the respondents had moderate self-management behavior levels, and CKD self-management was correlated with health literacy, CKD knowledge, self-efficacy, and social support, but not demographic factors.

The study revealed that age was not related to self-management behaviors during the predialysis stages of CKD, contrary to expectations. Other studies that explored this intricate relationship revealed a complex picture, and some found a negative relation across patients with all CKD stages[15] and on hemodialysis,[17] while others demonstrated a positive association in early CKD stages between age and self-management.[30] Interestingly, older patients on hemodialysis demonstrated a notably positive correlation with the fluid management aspect of self-care,[27] possibly indicating that older people pay greater attention to health and healthier behaviors than younger ones.[34]

Our results revealed that gender was not related to self-management behaviors in the predialysis CKD population, unlike the former study.[34] Gender showed an association with self-care behaviors in the Burmese hypertensive community, and women spent less time on healthy lifestyle activities.[34] In contrast, women on hemodialysis tended to be more likely to adhere to self-care activities.[17] The predialysis population examined in the study could be considered to differ from the population of two previous studies on hypertension and hemodialysis. Patients on hemodialysis may have more symptoms and complications that they need to take care of themselves daily, such as diet, lifestyle, and medication, unlike patients with hypertension.

Marital status was not related to the self-management behavior of patients with predialysis CKD. On the contrary, some studies revealed that single or married participants performed CKD self-management more than CKD people who were widowed or separated.[18] In contrast, single participants engaged more in self-management than participants in other marital conditions.[15] Most participants in the study were married, similar to previous studies, but the statistical analysis used differed, causing potentially different findings.

Education level showed no association with patients with predialysis CKD self-management behaviors in this study, which was inconsistent with previous studies. Patients with CKD performed better self-management behaviors accordingly with the higher educational level on various CKD stages.[17,23,24,30] This might be due to the participants' different categories of educational levels and the use of different instruments in the study.

This study revealed no significant association between CKD duration and self-management behaviors. A previous study reported that patients on predialysis with longer disease duration performed better self-management activities, unlike ours.[16] Additionally, a study on chronic heart failure revealed similar results in which most participants had more than one year of disease duration.[35] However, more than half of the participants in this study had been diagnosed with CKD for ≤1 year. The short duration of having CKD may be insufficient to view the relationship with self-management behaviors.

Based on social cognitive theory, health literacy as an individual's cognitive factor has a reciprocal relationship with the physical or social environment and behavioral outcomes.[36] Health literacy is essential to information processing, such as finding, understanding, judging, and applying health information for people. Patients having CKD tended to perform their self-management to control the disease. The participants had a moderate overall health literacy level. Additionally, a positive relationship between health literacy and CKD self-management behaviors was noted in the predialysis stages of this study, which is congruent with other studies.[15,37] However, health literacy and all self-care behaviors demonstrated no relationship in the low-income CKD population,[19,38] in which different questionnaires, such as 3-item questions, are used to test health literacy, and further research is needed to better understand the relationship between health literacy and self-management behavior.

As a conceptual framework of this study, knowledge is significant to improve the level of understanding for performing a behavior by cognitive process.[39] Patients with CKD must have disease-specific knowledge to perform such complicated CKD management better.[40] This study showed that participants demonstrated moderate CKD knowledge, and CKD knowledge had a strong relationship with self-management behaviors in patients with predialysis CKD. The higher the CKD knowledge that patients have, the better self-management behaviors they perform. This finding was strengthened by former studies.[22–24,41,42] Moreover, objective and perceived kidney disease knowledge had a positive trend related to CKD self-care.[19]

According to Bandura's theory, one's belief in ability or efficacy is a key construct in performing challenging activities, whether the person initiates coping behavior, how much effort the person expends, or how persistent the person is in facing obstacles.[11] Self-efficacy is an exclusively important factor in practicing complicated self-management behaviors, such as treatment-related activities, symptom management, and proper use of recommended pharmacological management, in their daily life.[22] The participants demonstrated a moderate overall self-efficacy level, and self-efficacy is also known to be a factor associated with CKD self-management behaviors in the predialysis population. The result was supported by previous evidence among patients on predialysis,[22,23,30,42] all CKD stages,[26] and hemodialysis.[17,20,24]

Maintaining health behaviors is not solely an individual matter in terms of conceptual framework. Furthermore, social facilitators, or supporters, are core elements to achieving behavioral changes.[14] The helpful social environment could deeply influence the sophisticated self-management behaviors to modify the patients' daily activities.[15] Besides, having support from three sources (significant ones, family, and friends) was beneficial for patients psychologically in the way of coping mechanisms and positive appraisal of the condition and reducing emotional stress.[43] The study analysis revealed that the participants had a high level of social support, and patients with predialysis CKD showed a positive correlation between social support and self-management behaviors. It is similar to previous studies, in which social support is a predictable factor for improving self-management at all CKD stages[15] in patients on hemodialysis.[44]

In summary, Bandura indicated that behavior came from the reciprocal interaction of personal factors and environmental factors. A person with good health literacy and knowledge level would engage more in healthy behaviors. Similarly, they will perform healthy behaviors if they have high self-efficacy. Social support as an environmental factor is also important to strengthen healthy behaviors.[45]

Some demographic findings of the study did not show a correlation with self-management behaviors. Therefore, further studies are indicated to confirm the study results. Future projects for improving self-management behaviors among the predialysis CKD population in Myanmar should consider any age group, gender, marital status, and

educational levels. The strength of the study is that the findings emphasized the level of self-management behaviors and related factors in the targeted population. This could provide healthcare professionals with some ideas that should be considered significant factors to help improve the self-management behaviors of the predialysis CKD population for future projects in Myanmar.

However, this study had some limitations. First, recruitment by convenience sampling method in private sectors (private hospitals in the upper and lower part of Myanmar) might not represent the CKD population in Myanmar, and the findings might have limitations to conclude generalizations of all Burmese patients with CKD. Second, the long questionnaire response period might cause boring and biased responses. The participants might not recognize symptom management and recommended self-management behaviors due to rare symptoms in the early CKD stages. However, more than half of the participants in this study were predominantly in stage-4 CKD. They might experience many symptoms and high engagement in symptom management/self-management behaviors compared to the rest of the participants. Finally, the social cognitive theory excluded biological and hormonal predispositions that may impact the self-management behaviors of the participants.

CONCLUSIONS

This cross-sectional study, guided by social cognitive theory, recommended initiating health education programs or workshops to boost CKD knowledge, self-efficacy, and social support levels. In contrast, a comprehensive self-management program considered its related factors indicated for patients with predialysis CKD. Future predictive or interventional studies should be conducted on other geographical areas for general governmental hospitals and evaluated for the outcomes of the predialysis population in Myanmar.

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CONFLICT OF INTEREST

Nothing declared.

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Association of Parenting Style and Mindful Eating with Sodium Intake among Adolescents in Indonesia

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Association of Parenting Style and Mindful Eating with Sodium Intake among Adolescents in Indonesia

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Abstract

Background: Most adolescents have an excessive sodium intake associated with hypertension and cardiovascular disease (CVD). Parents have an important role in controlling adolescents' nutritional intake, including sodium, through healthy eating. Mindful eating is considered healthy eating with the potential to control nutritional intake. This study aims to analyze the association of parenting style and mindful eating with sodium intake among adolescents.

Methods: This cross-sectional study involved adolescents aged 15–18 years. Sodium intake was measured by repeated 24-hour food recall. Parenting style was examined with a validated parenting style and dimensions questionnaire self-administered by the adolescent parent. Mindful eating was evaluated using a mindful eating questionnaire (MEQ) self-administered by the adolescent. Data were analyzed using Kruskal–Walls and Spearman correlation.

Results: Parenting style has no significant association with sodium intake, and mindful eating has a negatively significant correlation with sodium intake ($p < 0.05$; $r = -0.17$).

Conclusions: Parenting style has no direct association with sodium intake. However, mindful eating has a significant association with sodium intake and parenting style. Mindful eating shows potential as a mediator between parenting style and sodium intake.

Keywords: adolescents, cross-sectional studies, parenting, sodium chloride dietary

INTRODUCTION

Excessive sodium intake indicates an unhealthy diet associated with an increased risk of noncommunicable diseases, such as high blood pressure, obesity, and cardiovascular disease (CVD).[1] In Indonesia, an association was observed between excessive sodium intake and high blood pressure, a CVD risk factor.[2] A prospective cohort study in Indonesia found that adults who consumed more than or equal to 2000 mg/d of sodium had higher hypertension incidences than those consuming < 2000 mg/day.[3] Therefore, an unhealthy diet, including high sodium intake, must be addressed in adolescence. However, most adolescents currently have an excessive sodium intake.[4] A previous report indicated the average sodium intake was 3214 mg/day among children and adolescents aged 7–18.[5] Another study from an individual consumption survey in 2014 revealed the mean sodium intake at 2748 mg/day.[6] According to the World Health Organization recommendation, sodium intake must not exceed 2000 mg daily.[7] A diet survey in 2014 showed that 55.7% of adolescents consumed more than 2000 mg/day of sodium, making them the age group with the highest proportion of excessive sodium intake. Regarding gender, boys consume more calories and, therefore, tend to have a higher sodium intake than girls.[6] Furthermore, excessive sodium intake is common in adolescents with low economic status.[8]

The sources of sodium are quite affordable and frequently aggressively marketed.[8] A survey of individual consumption in 2014 revealed that the food items mainly contributing to the sodium intake of adolescents (13–18 years old) were salt (44.3%), noodles (12.9%), and seasoning (8.4%).[6] In 2020, the Ministry of National Development Planning reported that the main snack types consumed by adolescents were ultra-processed food, chips, and fried food that commonly contain high sodium.[9]

Adolescence is one of the critical periods that determines the health status in adulthood, and nutrition plays a substantial role in the well-being and development of adolescents.[4] Excessive sodium intake is a characteristic of an unhealthy diet that cannot be separated from the role of parents as role models and food procurers, which are closely related to shaping adolescents' food intake. Parents' low education is predicted to have a negative association with sodium intake. Moreover, effective parenting during this period can have a positive and lasting effect on adolescents' health. Parenting style is one of the psychosocial factors important in shaping the diet of adolescents, including sodium intake, because family is the first and the closest environment for adolescents.[10] According to Baumrind, the three parenting styles are authoritative, authoritarian, and permissive. Authoritative practices are characterized by high warmth and less

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control and recommend cultivating children's interest in food to increase food acceptance. Meanwhile, authoritarian parties tend to be less warm, have high control, and prefer child-feeding practices. In contrast, permissive parents are warmer but less controlling and allow their children to eat whatever they want.[11]

Authoritarian and permissive parenting styles have been linked to unhealthy diets.[12] A longitudinal study found that after two years of follow-up, boys with authoritarian mothers were significantly ($p < 0.05$) less likely to eat fruit and vegetables.[13] Boots *et al*. found that low warmth was associated with a high preference for unhealthy food.[14] Some parents that are less controlling allow adolescents to have a long screen time[15] and possibly order online food.[16] Arifiani *et al*. showed that commonly ordered food choices were categorized as high-sodium food.[16]

Authoritative parents show adolescents how to eat and improve their health without coercion (e.g., increased physical activity and consumption of fruits and vegetables).[12] This finding aligns with the two cross-sectional studies of Peters *et al*., who found that the authoritative parenting style is linked to healthy dietary intake, including a high intake of fruit and vegetables.[17] This finding also aligns with research on older children (5–18 years old), indicating that the authoritative parenting style is related to increased diet quality.[18] Goodman *et al*. also showed that authoritative practice can improve adolescents' eating behavior toward less emotional eating.[19] Less emotional eating is also known as mindful eating, which involves physical and emotional senses to experience and enjoy the food being eaten to increase awareness and focus on eating while paying attention to hunger and satiety cues. Authoritative parenting is considered a positive parenting style that promotes adolescents' well-being by shaping their mindful eating behavior,[19] which is predicted to prevent excess sodium intake.[20] Therefore, mindful eating may mediate parenting style and sodium intake.

Parenting style has been linked to dietary intake, and the authoritative style is likely to have a positive impact on the same. This view is supported by a previous review of seven articles, five of which found the association of authoritative or high warmth and control with a high intake of fruit and vegetables and a low intake of unhealthy food.[12] The study also showed that research regarding parenting style and sodium intake among adolescents is still limited and thus requires further exploration. Therefore, the present work aims to analyze the association among parenting style, mindful eating, and sodium intake.

METHODS

A cross-sectional study was conducted in Surabaya, one of urban cities in Indonesia. According to the 2018 Indonesian National Basic Health Research, the prevalence of overweight and obesity in Surabaya (17.8%) was higher than the national level (13.5%).[21] Agustina *et al*. reported that the prevalence of overweight and obesity in older adolescents in 2018 was almost double that in 2013, with an increase of 6.2%.[22] This increase was higher than the prevalence in younger adolescents (5.2 %).[22] Therefore, the present study recruited adolescents from either public or private senior high schools in Surabaya as the respondents. Twenty students were chosen randomly from each school based on the inclusion criteria (aged 15–18 years old, have a mobile phone and internet connection, and are willing to participate in the research). The exclusion criteria included health problems that require special treatment or diet and the inability to communicate normally. The study procedure was approved by the ethical committee of the Faculty of Medicine, Universitas Indonesia (KET-573/UN2.F1/ETIK/PPM.00.02/2022).

Instruments

The instruments used in this study consisted of a sociodemographic questionnaire, wealth index questionnaire, MEQ, Parenting Scale, Dimension Questionnaire (PSDQ), and 24-hour food recall.

Sociodemographic data (age, gender, parents' education, and wealth index) were obtained through interviews. If the parent graduated from junior high school, he/she was categorized as having < 12 years of education. If the parent graduated from senior high school or above, he/she was categorized as having ≥12 years of education. The education categories for parents were in accordance with government regulations regarding the 12-year compulsory education program. The questions were close-ended, and the enumerator input the code for the answer from the respondent. The wealth index questionnaire was adopted from the Indonesia Demographic Health Survey (IDHS) in 2017, carried out by the National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), and the Ministry of Health (Kemenkes). The respondents were interviewed regarding electricity and ownership of durable goods in households such as radio, television, nonmobile telephone, computer/laptop, refrigerator, fan, washing machine, air conditioner, watch, mobile telephone, bicycle, motorcycle, and private car. Score one was given for each durable goods that was owned by the respondent, and score two was given for each durable goods that was not owned by the respondent. Each score was then multiplied by the coefficient obtained from the IDHS database, and all the scores were added for each variable. The sum of the total answer score for each participant was categorized according to the coefficient percentile (lowest ≤0.04, low-middle ≤0.07, middle ≤0.12, middle-high ≤0.19, and highest ≤1.26).[23]

Parenting style was assessed using PSDQ, developed by Robinson *et al*. and widely used to measure parenting styles based on the three Baumrind parenting styles.[24] Its

Indonesian version is already available. In a previous study, PSDQ was backward-translated, pretested among the parents of 13- to 19-year-old children, and yielded Cronbach alpha of 0.80, 0.75, and 0.64 for authoritative, authoritarian, and permissive styles, respectively.[25] PSDQ consisted of 32 self-reported items for parents that covered three parenting styles: authoritative (15 items), authoritarian (12 items), and permissive (5 items). Every item was answered using the Likert scale (1 = never to 5 = always). The average score was calculated for each parenting style (authoritarian total score divided by 12, authoritative total score divided by 15, and permissive total score divided by 5). The highest average score among the three styles indicated the most dominant parenting style applied.[26] Internal consistency reliability from the preliminary study was good for authoritative and authoritarian styles and the whole construct (PSDQ-32 items) with Cronbach alpha = 0.91, 0.70, 0.84, respectively, but poor for permissive parenting with Cronbach alpha = 0.40. For the permissive style, the Cronbach alpha in the present study was lower than in the previous study. Nevertheless, many previous reports also showed barely acceptable internal consistency for the permissive style.[26]

Mindful eating was measured by the MEQ developed by Framson *et al*.[27], translated in Indonesia, and validated by Hilmia *et al*.[28] The validity of the MEQ–Indonesia version ranged 0.750–0.917 (Aiken's V)[28], according to the preliminary study, its reliability was 0.75 (Cronbach alpha). Therefore, the MEQ is a valid and reliable instrument. The MEQ is a self-administered questionnaire consisting of 28 items grouped into five domains (distraction = three items; disinhibition = eight items; external cues = six items; awareness = seven items; and emotional response = four items) and then answered using the Likert scale (1 = never/rarely, 2 = sometimes, 3 = often, and 4 = usually/always). Reverse scoring was applied to items 1, 2, 6, 7, 9, 11, 17, 18, 19, 27, and 28. Each item was summed based on the domain to generate the domain score excluding those with a "not applicable" response. The average of the five domain scores was taken as the mindful eating score. A high score indicated mindful eating.[27]

Sodium intake was assessed by interview using repeated 24-hour food recall once on weekdays and once on weekends; the results were then averaged. During the interview, a food picture book was used to assist the respondents in estimating the portion of food consumed. After the list of food consumed was obtained from the 24-hour food recall, the sodium content for each food was estimated. For cooked food, the salt added during cooking was estimated using the guideline from the Ministry of Health containing a list of food ingredients and their salt content per 100 grams of food. For packaged food, the sodium content was determined from the nutrition label printed on the back of the food packaging. The sodium content was estimated from the Indonesian Food Composition Table for raw food. All data on food consumption were entered into the nutrisurvey® software to calculate sodium intake.[29]

Study procedure

After ethical clearance was obtained, randomization was performed to select the schools for research locations. Research permits were applied through the provincial education office and then forwarded to the selected schools.

Enumerators were recruited from nutritional science majors and trained by experts to perform a 24-hour food recall with the multiple pass method, a structured way to recall the diet for the whole day. The steps included collecting all-day uninterrupted diet memories (pass 1), asking for details of the individual foods and beverages listed (pass 2), followed by their portion sizes and recipes (pass 3), and summarizing all recalled food and beverages (pass 4).[30]

A preliminary study was conducted on 32 adolescents with the same inclusion and exclusion criteria to ensure that the instruments used were valid and reliable and that those adolescents and their parents understood the questionnaire they would fill out. The reliability and validity of instruments for the preliminary study were mentioned in the instrument section.

During data collection, the researchers visited the school and requested informed assent from adolescents who were willing to participate in this study. Informed consent and PSDQ form were then provided to the adolescents to give to their parents at home. An explanation of the PSDQ form was also given to the adolescents to pass on to their parents. Each parent willing to be involved in this study can sign the informed consent and fill out the PSDQ in the home. The contact person of the researcher was also provided in case the parent needed further information, and a WhatsApp group was created with the adolescents to follow up and ensure the PSDQ form was filled out according to the instructions on the form. The next day at school, the PSDQ forms that their parents had filled out were collected. The respondents were then interviewed regarding their sociodemographic and sodium intake through a 24-hour food recall. Next, they were asked to independently fill in the MEQ via the Google form on their cell phones. For the weekend 24-hour food recall, an appointment was made to interview the respondents on Monday.

Data analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS IBM Corp.) version 22 for Windows. The normality of data distribution was tested using Kolmogorov–Smirnov. The descriptive analysis of sociodemographic variables (age, sex, parent's education, and parent's occupation), wealth index, mindful eating,

parenting style, and sodium intake were presented as mean ± SD or median (minimum-maximum) for continuous data and number (%) for categorical data. Spearman correlation was used to analyze age, mindful eating, and sodium intake associations. Mann–Whitney was applied to analyze the associations among gender, parents' education, and sodium intake. Kruskal–Wallis was employed to analyze the associations among wealth index, parenting style, and sodium intake. The statistical significance limit was accepted as $p < 0.05$.

RESULTS

The demographic characteristics are shown in Table 1. Among the 240 subjects, 60.4% are female, with a mean age of 16.7 ± 0.7 years old. Data on age are normally distributed with Kolmogorov–Smirnov ($p > 0.05$). Most of the adolescents in this study have a high wealth index (81.7%). The characteristics of the adolescent's parents included their education and occupation. The majority of adolescents' parents in this study have education attainment of ≥12 years. The authoritative parenting style (98.8%) is applied by most of the adolescents' parents in this study (Table 1).

The scores of mindful eating (average 2.7 ± 0.2) are normally distributed with Kolmogorov–Smirnov ($p > 0.05$). The sodium intake average is 1665.6 (76.1–3550.9), and the data are not normally distributed with Kolmogorov–Smirnov ($p < 0.05$).

The adolescents' demographic characteristics and sodium intake are presented in Table 2. The correlation between age and sodium intake is insignificant ($p = 0.530$; r = 0.04). Similarly, gender, wealth index, and parents' education have no significant association with sodium intake. In terms of gender, males have a higher sodium intake than females.

Table 2 also presents the association between parenting style and sodium intake analyzed using Kruskal–Wallis test. The results showed no significant p-value (0.587). Among the parenting styles, authoritative is associated with the lowest sodium intake.

Spearman correlation analysis was performed between mindful eating and sodium intake. A negatively significant correlation is observed ($p = 0.007$; r = −0.17), which indicates that a high mindful eating score is associated with a low sodium intake.

The results of one way-ANOVA for parenting style and mindful eating are displayed in Table 3. A significant mindful eating score of 3.2 ± 0.0 associated with permissive parenting style. Authoritative and authoritarian have the same mindful eating scores.

TABLE 1. Demographic characteristics of adolescents and descriptive analysis of parenting styles (N = 240)

Variables	N (%)
Gender	
Female	145 (60.4)
Male	95 (39.6)
Wealth index	
Highest	196 (81.7)
Middle-high	13 (5.4)
Middle	4 (1.7)
Middle-low	10 (4.2)
Lowest	17 (7.1)
Father's education	
<12 years	37 (15.4)
≥12 years	203 (84.6)
Mother's education	
<12 years	43 (17.9)
≥12 years	197 (82.1)
Parenting styles	
Authoritative	237 (98.8)
Authoritarian	2 (0.8)
Permissive	1 (0.4)

TABLE 2. Characteristics of adolescents and sodium intake (N = 240)

Characteristics of participants	Sodium intake	*p*
Gender[a]		
Female	1532.2 (76.1–3660.9)	0.084
Male	1969.2 (512.6–3482.1)	
Wealth index[b]		
Highest	1695.2 (76.1–3550.9)	
Middle-high	1406.7 (574.5–3487.0)	
Middle	1811.7 (1564.5–2407.1)	0.463
Middle-low	2258.1 (398.6–2816.4)	
Lowest	1443.2 (108.1–3474.1)	
Father's education[a]		
<12 years	1564.5 (108.2–3487.0)	0.317
≥12 years	1691.4 (76.1–3550.9)	
Mother's education[a]		
<12 years	1594.3 (108.2–3531.9)	0.816
≥12 years	1676.9 (76.1–3550.9)	
Parenting style		
Authoritative	1654.4 (76.1–3550.9)	
Authoritarian	1662.2 (1315.7–2008.7)	0.587
Permissive	2371.5	

[a] (Mann–Whitney U); [b] (Kruskal–Walls); Values are presented in median (min-max)

TABLE 3. Parenting style and mindful eating (N = 240)

Parenting style	Mindful eating score	*p*
Authoritative	2.6 ± 0.2	
Authoritarian	2.6 ± 0.2	0.033*
Permissive	3.2 ± 0.0	

Values are presented mean ± SD; *Significant $p < 0.05$

DISCUSSION

This study aimed to investigate the association between parenting style and sodium intake in adolescents. Baumrind categorized parenting style as authoritative (identified by organized guiding that integrates the child's specific preferences), authoritarian (defined by strict adherence to parental norms and limited encouragement of child autonomy), and permissive (characterized by indulgence and provides minimal structural guidance to the child).[11]

Results showed no significant associations between adolescent characteristics and sodium intake. Furthermore, the association between parenting style (authoritative, authoritarian, and permissive) and sodium intake was insignificant. This finding is similar to the study on 1614 parent–child pairs that found no significant association between general parenting style (measured by using a questionnaire and completed by one of the parents) and dietary habit (measured by food frequency questionnaire/FFQ) in logistic regression.[31]

Other studies presented different results. Monroe *et al*. examined the association between parenting practice and food group (dairy, fruit, vegetable, and unhealthy snack) consumed in younger adolescents and found that authoritative parenting style has a negatively significant correlation with unhealthy snack consumption.[32] Furthermore, Lopez *et al*. conducted a study among 174 mother–child pairs with a mean child age of 10 years and showed an insignificant direct effect of the three types of parenting style (measured by using PSDQ) on children's dietary intake.[33] They also performed further analysis on mediation, in which the parenting practice was assumed as the mediator. The results showed that the authoritative parenting style indirectly affects children's dietary intake through mealtime structure (one of the parenting practices).[33]

Several possible reasons can explain the above difference. First, the difference may be due to the measurement of parenting style, which is not relatively insensitive to measuring dietary intake. Moreover, parenting styles can differ among individuals (mother or father) and time. Therefore, the measurement of parenting style must be person- and time-specific.[31] However, the present study did not count the number of fathers or mothers who fulfilled the PSDQ. According to Lopez *et al*., parenting style indirectly affects the dietary intake of children and adolescents; however, they did not assess parenting practice as a potential moderator between parenting style and sodium intake.[33] Moreover, a domain or parenting style-specific analysis will benefit more than a general analysis.

Furthermore, a previous study showed that parenting style (authoritative, authoritarian, and permissive) may have an indirect effect on child eating behavior, and this influence is mediated by mindful eating.[19] Mindful eating originates from mindfulness, a basic human ability to pay attention to what is happening inside and outside the individual. Mindfulness applied to eating is termed mindful eating, which refers to raising awareness of the physical and emotional sensations associated with eating.[27] Mindful eating as a parenting practice is predicted to have a positive impact on the dietary intake of children and adolescents. Therefore, we also analyzed the relationship between mindful eating and sodium intake and found their negatively significant correlation. This finding is in line with the study of Kartika *et al*., who discovered a negatively significant association between mindful and intuitive eating and calorie intake in female teenagers.[34] The cross-sectional study among 546 university students also found a negative significant correlation between mindful eating and sugar and fat intake.[35]

Mindful eating is characterized by less distraction and emotion and great focus when eating.[27] A similar result was obtained by Jordan *et al*. who explored the effect of a 15-minute mindful eating practice on food intake in 60 university students.[36] The participants in the intervention group listened to an audio recording regarding mindfulness instruction that asked them to focus on the physical signal from their bodies. Meanwhile, the participants in the control group listened to an audio recording focused on relaxation without mindfulness. All the participants were then asked to eat snacks. Compared with those in the control group, the participants exposed to mindfulness practice consumed 24% fewer calories. The overall energy intake of the participants in the experimental and control groups was 149 calories and 198 calories, respectively.[36] This finding illustrates that mindful eating has the potential to control food intake, including sodium intake.

We also analyzed the relationship between parenting style and mindful eating and found that parenting style has a significant association with mindful eating. This finding is in line with the study of Goodman *et al*., who found that the authoritative parenting style is significantly related to high mindful eating scores, and authoritarian and permissive parenting styles are significantly related to low mindful eating scores.[19] Although the present study found that the permissive parenting style has the highest mindful eating score, this conclusion is not substantial because only one subject applied this parenting style in this study.

Duncan *et al*. suggested that when parents integrate mindful eating into their practice, they take care of their children in a value-consistent manner instead of merely replying automatically.[37] All these findings imply that parenting style combined with mindful eating can benefit children and adolescents' dietary habits. Although a

previous study classified mindful parenting as a new parenting style, this concept requires further exploration.[38]

The strength of this study lies in the preparation phase: we ensured that all instruments were valid and reliable by conducting a pretest. To accurately manage the dietary assessment, we recruited all the enumerators from the nutrition science program and had an expert train them regarding the sodium intake assessment. Considering that the 24-hour food recall relies on estimation and is prone to bias, we tried to minimize bias using a food picture book (published by the Indonesian Ministry of Health) during sodium assessment to help the respondents estimate the portion of the food consumed.

The limitation of this study is the memory lapses during sodium intake assessment using 24-hour food recall. Due to the limited data collection time in the field, the researcher could not visit the respondent's house to determine who filled out the PSDQ. The assessment of parenting style is not quite as sensitive as the dietary assessment. In addition, the parenting style will be more visible if each parenting style score is analyzed rather than just selecting the predominant parenting style score. Future studies must explore the potential of mindful eating as a mediator between parenting style and sodium intake. Moreover, parenting style should be measured separately between fathers and mothers.

CONCLUSIONS

Parenting style showed an insignificant direct effect on sodium intake. Further analysis revealed that mindful eating had a significant association with parenting style and sodium intake. Thus, mindful eating manners can be a mediator for parenting style and sodium intake. Further exploration of parenting style and sodium intake is warranted.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Premenstrual Syndrome Levels and Eating Attitudes Among University Students

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Premenstrual Syndrome Levels and Eating Attitudes Among University Students

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Abstract

Background: Premenstrual syndrome (PMS) is the combination of physical, behavioral, and psychological symptoms that characterize the week leading up to menstruation, and it can last for a few days. This study aimed to investigate irregular PMS, eating attitude behavior, and body mass index values among university students.

Methods: The study sample consisted of 140 Artvin Coruh University students studying Nutrition and Dietetics. The study includes questions from three separate sections. The first section contains a sociodemographic characteristic form, the second section consists of the Premenstrual Syndrome Scale (PMSS), and the third section includes the 26-item Eating Attitude Test (EAT-26).

Results: In this study, the mean total score for PMSS was 135 ± 38.3, and the mean total score for EAT-26 was 17.0 ± 10.8. Individuals with irregular sleep patterns experienced more severe PMS ($p < 0.01$) and a shorter daily sleep duration ($p < 0.05$).

Conclusions: High percentages of nutrition and dietetics students in our study experienced PMS, and the incidence of eating disorders was low. The relationship between PMS and EAT-26 must be understood for the health and well-being of university students.

Keywords: attitude, premenstrual syndrome, students

INTRODUCTION

Premenstrual syndrome (PMS) is a condition characterized by distressing physical, behavioral, and psychological symptoms that indicate the week leading up to menstruation, and it can last for a few days. The intensity of PMS among women can vary due to hormonal, psychosocial, and physiological factors.[1] Women with PMS experience emotional or somatic symptoms that can cause considerable impairment in social or occupational malfunctioning. The onset of PMS symptoms occurs at any age after menarche, and their severity tends to intensify with age; however, these symptoms decrease as menopause approaches.[2] PMS symptoms include feelings of tension, depressive mood, decreased concentration, headache, changes in appetite (increased or decreased), cravings for sweet, salty, or spicy foods, alterations in study habits, excessive sleep or insomnia, and clumsiness. During the premenstrual period, these symptoms can adversely affect university students' daily activities, class attendance, academic performance, emotional well-being, and family relationships.[3] The prevalence of PMS within society and its influencing factors must be determined to describe its etiology and to enable planning efforts for its treatment.[4] Despite the existing research on PMS in women, the studies conducted on young adults are limited. The prevalence of PMS ranges between 36.3%–91.8%, according to the related research conducted on students in Turkey.[5,6]

Eating disorders refer to psychiatric illnesses characterized by abnormal eating habits. Complications, such as nutritional, psychiatric, and physical health disorders, accompany these conditions. Eating disorders may include nonclinical eating disorders, such as being excessively fat or excessively dieting, and clinically severe forms, such as anorexia nervosa and bulimia nervosa. Eating disorders are more prevalent in individuals under the age of 25 and predominantly affect women.[7] The risk factors for developing eating disorders include biological, psychological, and environmental factors. Most risk factors of disordered eating and eating disorders are specific to college environments. The increased growth and development rate during adolescence increases an individual's need for nutrients and energy. Adequate and balanced nutrition is crucial during this period. Moreover, during this phase, hormonal fluctuations in the menstrual cycle can negatively affect a female's appetite control and eating behavior.[8]

Adolescents transitioning from high school to college are exposed to various novel environmental factors that affect them differently. Most of these factors contribute to developing and exacerbating disordered eating behaviors. Given the competitive college education environment and the pursuit of excellence among peers,

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the demand for adaptation to new environments increases.[9,10] Özkan *et al*. identified a positive correlation between PMS and eating attitudes in adolescents.[11] They observed that 23.1% of adolescents experiencing PMS showed eating attitude disorders.

Since a considerable proportion of lean body tissue is composed of water, changes in body water during the menstrual period can affect women's body composition. Many women report experiencing temporary weight gain during their premenstrual phase, often attributed to water retention and bloating. This condition can cause a minor increase in the body mass index (BMI) during such period, but it is typically temporary and reverses once menstruation begins.[12]

PMS itself is unlikely to have a substantial long-term effect on the BMI. However, if the changes in eating behaviors associated with PMS lead to consistent overeating or unhealthy dietary choices over time,[1] they can contribute to weight gain and potentially affect BMI in the long run. An increased appetite, particularly for carbohydrate-rich and sweet foods, has been observed in some individuals with PMS. Such eating behavior is often attributed to hormonal fluctuations during the menstrual cycle, which can lead to cravings.[13] This study aimed to investigate irregular PMS, eating attitude behavior, and BMI values among university students.

METHODS

Research sample

The study sample comprised voluntary students enrolled in the Nutrition and Dietetics Department of Artvin Coruh University Faculty of Health Sciences during the academic year 2021–2022. This research was approved by the Artvin Coruh University Ethics Committee (04.01.2022-34728) and included 140 students. The data for descriptive research was collected through an online survey form created on Google Forms using the snowball sampling method. The inclusion criteria for the study group were as follows: a regular menstrual cycle, no history of psychiatric illness nor severe trauma in childhood, no diabetes and renal or hepatic diseases, no special diet, no form of any hormone therapy received in the last two months, and not using antidepressants.

Data collection

This research aimed to determine the levels of PMS, eating attitude behavior, and anthropometric characteristics among university students and involved the administration of three sections of questions. The first section included questions regarding the students' age, sleep patterns, exercise status, and anthropometric characteristics; the second the Premenstrual Syndrome Scale (PMSS); and the third the 26-item Eating Attitude Test (EAT-26). The participants' BMI values were calculated using the kg/m^2 formula based on their weight and height measurements.

Premenstrual syndrome scale

The PMSS was developed by Gençdoğan, and its validity and reliability were tested in this work.[14] The calculated Cronbach's alpha coefficient of the scale was 0.75. PMSS is a 44-item five-point Likert-type scale and consists of nine subdimensions (depressive mood, anxiety, fatigue, irritability, depressive thoughts, pain, changes in appetite, changes in sleep, and bloating). In the scoring of the scale, "never" (1 point), "very little" (2 points), "sometimes" (3 points), "often" (4 points), and "always" (5 points) are evaluated. The lowest score on the scale is 44, and the highest is 220. A score of 50 or higher indicates that the individual is experiencing PMS.

Eating attitude test-26

The Eating Attitude Test-26 (EAT-26) is used to assess the risk of eating disorders. EAT-26 test is a short version of the 40-item EAT developed by Garner *et al*.[15] The total score in EAT-26 is calculated by scoring the answers to the first 25 questions are as "always" (3 points), "usually" (2 points), "often" (1 point); "sometimes," "rarely," and "never" are scored 0.[8] The scoring for the 26th question is different, with "never" (3 points), "rarely" (2 points), "sometimes" (1 point), and "often," "usually," and "always" being scored 0. In this study, the scale total score was determined using these values. Individuals who scored 20 or more points on the test were considered to have an eating disorder. The calculated Cronbach's alpha coefficient of the scale was 0.84.

Statistical analysis

Statistical analyses were conducted using the SPSS Statistics 26 package program (SPSS Inc., Chicago, Illinois, ABD). After normality analyses, the independent sample T-test was used to evaluate differences between groups. Correlation analysis was performed using Pearson correlation on the data that showed a normal distribution. A p-value of < 0.05 was considered statistically significant in data evaluation.

RESULTS

The mean, standard deviation, and range of PMSS and EAT-26 were 134.69 ± 38.30 (55–211) and 16.57 ± 9.94 (2–49) respectively. Cronbach's alpha reliability coefficients were examined for the reliability levels of the measurement tools. The Cronbach's alpha reliability coefficients were 0.97 for PMSS and 0.85 for EAT-26. These reliability coefficients show that Cronbach's alpha has sufficient reliability in both scales.

As shown in Table 1, 85% of the participants do not smoke, and 90% do not use alcohol. Approximately 45.7% of the students have dieted before, and about 50.7% have used dietary supplements. Around 32.9% of the students engage in sports. However, 33.6% suffer from an eating disorder. According to the scale results, participants with an EAT-26 score of 20 or higher exhibit an eating disorder.

TABLE 1. Frequency analysis of other characteristics of the participants (N = 140)

Participants' characteristics	N	%
Previously going on a diet		
Yes	64	45.7
No	76	54.3
Engaging in exercise		
Yes	46	32.9
No	94	67.1
Using dietary supplements		
Yes	71	50.7
No	69	49.3
Sleep schedule		
Regular	49	35.0
Irregular	91	65.0
Smoking		
Yes	21	15.0
No	119	85.0
Using alcohol		
Yes	14	10.0
No	126	90.0
Menstrual cycle regularity		
Regular	113	80.7
Irregular	27	19.3
Seeking medical attention for menstrual pain		
Yes	34	24.3
No	106	75.7
Eating attitude		
Yes	47	33.6
No	93	66.4
PMSS		
Yes	140	100.0
No	0	0.0

TABLE 2. Values for age, BMI, sleep duration, and age at first menstruation

Variables	Mean ± SD	Min – Max
Age	21.6 ± 1.3	19 – 24
Height	163.7 ± 5.3	153 – 176
Weight	57.2 ± 7.5	43 –78
BMI	21.4 ± 2.7	16.5 – 28.6
Daily sleep hours	7.7 ± 0.9	6 – 9
Age of first menstruation	13.6 ± 1.2	12 – 17

Approximately 19.3% of the students reported having irregular menstruation, and around 24% had consulted a doctor for menstrual pain. A score of "50" or higher on the PMSS indicates that an individual experiences PMS. Most importantly, in our study, all participants reported having experienced PMS. Therefore, our sample consisted entirely of individuals experiencing PMS.

The students included in this study had an average age of 21.6 ± 1.3 years, average BMI of 21.4 ± 2.7, average daily sleep duration of 7.7 ± 0.9 hours, and average age at menarche equal to 13.6 ± 1.2 years (Table 2).

In individuals with eating disorders, according to the EAT-26 scale, as age and age at first menstruation decreased, the BMI increased (Table 3). However, this result was not statistically significant ($p > 0.05$). This finding can be attributed to the small sample size used in this research. Regardless, this outcome shows that the early onset of menstrual bleeding affected the BMI of our sample of individuals with PMS. Correlation analysis revealed a significant negative correlation ($p < 0.001$) between the level of experiencing PMS and the age of first menstrual bleeding. Among our participants with eating disorders, more severe PMS symptoms were recorded for women who experienced their first menstrual bleeding at an earlier age.

As shown in Table 4, the BMI of participants who had experienced PMS and had previously gone on a diet was significantly higher than those who had never dieted before ($p < 0.001$). We compared the responses of the participants who experienced PMS to our question about sleep patterns, including the daily sleep durations and PMS levels. Individuals with irregular sleep patterns experienced more severe PMS ($p < 0.01$) and reported a shorter daily sleep duration ($p < 0.05$).

TABLE 3. Pearson correlation results for BMI, age, age at first menstruation, and PMSS values in individuals with eating disorders (EAT-26)

	BMI	Age	Age of first menstruation	PMSS score
BMI	1	–0.065	–0.224	0.150
Age		1	0.119	0.162
Age of first menstruation			1	–0.467*
PMSS score				1

*$p < 0.005$ (Pearson's correlation analysis)

TABLE 4. Comparison of BMI, PMSS, and daily sleep time of different groups

	Mean ± SD	*p*
Previously going on a diet	BMI	
Yes	22.8 ± 2.7	0.000*
No	20.2 ± 2.1	
Sleep schedule	Daily sleep duration	
Regular	7.9 ± 0.7	0.029*
Irregular	7.5 ± 1.0	
Sleep schedule	PMSS	
Regular	123 ± 41	0.009*
Irregular	141 ± 36	

*Independent sample t-test

DISCUSSION

University years define the transitional period between the late stages of adolescence and the beginning of early adulthood. During this period, young people, who are normally accustomed to their family environment, experience increased stress levels caused by changes in their nutrition and housing habits.[16] PMS, although commonly occurring during adolescence, is one of the major problems encountered during this period. PMS negatively affects women's family, work, and social relationships, leading to loss in education and workforce, decreased job performance, increased error/accident rates, alcohol/substance use, and a tendency to commit crime; it can also cause mothers to behave negatively toward their children.[17,18]

In our study, the prevalence of PMS was 100%, and the PMSS score was 135 ± 38.3. Tanriverdi *et al*. examined the frequency of PMS among university students and observed a PMS prevalence of 67.5%.[6] Pinar *et al*. reported that 72.1% of the students they studied experienced PMS.[19] Erbil *et al*. determined a PMS prevalence of 49.7% among university students.[20] Another study on 254 women aged 18–45 who were studying or working at university revealed an 80.2% prevalence in PMS.[21] Most importantly, our study revealed that all participants experienced PMS. When we compared our findings with the frequency of PMS in studies conducted among students in our country, the most remarkable finding is that all participants experienced PMS.

Sleep is one of the fundamental human needs, and it plays an important role in achieving a healthy life. Insufficient sleep poses a threat to health and leads to a decrease in cognitive, psychomotor, and emotional functions. In our study, the mean daily sleep duration of the participating students was 7.7 ± 0.9 hours. Students with irregular sleep patterns experience more severe PMS and a shorter daily sleep duration compared with other participants.[22]

Other factors that may affect the presence of PMS include smoking, alcohol consumption, and exercise.[23,24] A previous study reported that smoking, especially during adolescence and young adulthood, increases the risk of PMS development, and the incidence of PMS is higher in those who start smoking during adolescence.[25] Another study observed that smoking was more common in those with PMS and that the severity of PMS increased as the amount of smoking increased.[26]

In our study, the percentage of PMS was 100% among smokers, drinkers, nonsmokers, and nondrinkers. Smoking and alcohol consumption were not determinative factors of PMS. A previous study observed that the BMI was higher in individuals with PMS than those without.[27] Another study revealed that bloating and premenstrual food cravings were more common in individuals with a BMI > 25 kg/m².[23] In our study, the BMI of participants who experienced PMS and had previously dieted was statistically significantly higher than those who had never dieted before.

Educated individuals or those who work in the health field are susceptible to eating because of their excessive interest in healthy eating.[28,29] A conducted on university students indicated that students enrolled in the nutrition and dietetics department had more dietary restrictions than others. However, no difference was observed between the two groups regarding eating disorder diagnosis. Compared with other students, students from the nutrition and dietetics department exhibited decreased orthorexia tendencies.[30] They engaged in healthier eating behaviors in their final year, as opposed to their first year.[30] In our study, 33.6% of individuals have eating disorders, with an average total score of 17.0 ± 10.8 on the EAT-26. EAT-26 scores of 20 or higher indicate the presence of an eating disorder. In our study results, a high percentage of the participants did not exhibit eating disorders. Moreover, 100% of the investigated nutrition and dietetics students experienced PMS, but the incidence of eating disorders among them was low.

Our study had a limited sample size. The generalizability of results could have been increased by using a more prominent and representative sample. Our study was not designed to establish a cause-and-effect relationship between PMS and EAT-26. More controlled experiments may be required in this regard. Despite these limitations, this study sheds light on the potential relationship between PMS and EAT-26. Future researchers can use larger sample sizes and different methodologies to investigate this topic further.

CONCLUSIONS

Factors such as university life, academic pressures, social stress, lifestyle changes, and hormonal fluctuations can exacerbate PMS symptoms. These symptoms typically manifest as mood swings, painful physical symptoms, and changes in eating behaviors. Particularly, alterations in

eating behaviors during the menstruation period make PMS an important concern for college students. Research tools such as EAT-26 are utilized to assess the relationship between PMS and eating behaviors, and understanding this connection holds importance for the health and well-being of college students. Therefore, comprehending the effect of PMS on university students and developing appropriate interventions are crucial research and clinical focus for young adults' health and quality of life.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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Cross-cultural Adaptation and Psychometric Properties of the Arabic Version of the Academic Nurse Self-Efficacy Scale

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Cross-cultural Adaptation and Psychometric Properties of the Arabic Version of the Academic Nurse Self-Efficacy Scale

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Abstract

Background: Students' academic self-efficacy is greatly associated with their academic performance. An effective instrument is needed to assess academic self-efficacy in the Saudi context. This study assessed the psychometric properties of the Academic Nurse Self-Efficacy Scale-Arabic version (ANSE-A) given to student nurses and the associations between the students' demographics and overall ANSE-A scores.

Methods: Quantitative and descriptive methods were applied. The study was conducted from January to July 2022 at Shaqra University with 200 nursing students as the convenience sample. For content validity, the item-level content and scale-level content validity indices were utilized following the averaging method. We used Cronbach's alpha (α) to measure the reliability. Meanwhile, for construct validity, we performed an analysis of the principal component with varimax rotation and applied a *t*-test and ANOVA for the tests of the association of variables.

Results: Four distinct factors were revealed in the factor analysis, and they explained 64.86% of the variance. The 14-item ANSE-A's overall Cronbach's alpha was 0.87, with four factors ranging from 0.74 to 0.76. The academic self-efficacy of the students was found to be associated with their gender and GPA. A weak positive correlation existed between the students' GPA and academic self-efficacy ($r = 0.17$, $p = 0.017$).

Conclusions: The ANSE-A is a valid and reliable instrument that can be utilized to assess the academic self-efficacy of student nurses in Saudi Arabia. The results of the assessment may be used to help boost nursing students' achievement and emotional health and serve as a valid predictor of motivation and learning.

Keywords: nursing students, psychometrics, reliability and validity, Saudi Arabia, self-efficacy

INTRODUCTION

Since the health sector is fast-growing and knowledge-intensive, nursing students must possess a high level of self-efficacy to meet its demands.[1] This will help them address the challenges associated with the profession. Self-efficacy focuses on a person's belief in their capacity to accomplish a certain assignment, and having a sense of achievement and completion is a form of strengthening to effect behavioral change.[2] In nursing, nursing students must have a solid intent to acquire the necessary skills, training, and judgment to apply in each professional situation. This helps them become more qualified and equipped with the beginning competency in clinical settings and accept the demanding role of being a nurse.

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Similarly, self-efficacy in clinical practice is an excellent predictor of nursing students' clinical practice performance.[3] A high degree of self-efficacy is essential for them to be able to engage in a variety of learning approaches.[4] Meanwhile, as cited by Shorey, self-efficacy is also an idea used in nursing education to link the theory-practice gap, gaining clinical skills, critical thinking, and general academic success.[2] Hence, for students' future career success, it is crucial for them to develop self-efficacy and self-confidence in the early stages of nursing education.[5]

In education, self-efficacy relates to viewing one's capacity to learn or perform successfully. It also pertains to utilizing self-regulatory learning processes, such as goal setting, strategy usage, self-monitoring, self-reaction, and self-evaluation.[6] It refers to one's capability to fulfill academic tasks and view concerning the successful learning of materials.[7] Consequently, the motivation of any learner depends on what they would receive in the end that would satisfy their definition of success. In

nursing education, overall course grades reflect various activities and assessments, such as lectures, case studies, assignments, group work, oral presentations, written examinations, clinical training, and laboratory lessons. However, these activities and objective assessments are not as good as self-efficacy in determining the academic performance of a nursing student. Unlike activities and assessments, self-efficacy serves as a mediator of the effects of students' prior attainment, understanding, and skills on subsequent success. Thus, possessing strong self-efficacy enables students to fulfill an assigned task, eventually excelling in it, with the mindset of perceiving complex skills as challenges instead of barriers.[7]

In nursing education, a close association has been observed between self-efficacy and clinical practice. The self-efficacy of nursing students enables them to give the best care possible to their patients.[8] Nurse educators should focus on providing instruction that encourages students to make accurate appraisals of their skills because their performance is potentially influenced by self-efficacy. Students must accurately estimate their abilities and calibrate their self-efficacy for task performance.[9] Students with greater self-efficacy are more vigorous in accomplishing their clinical work and are more likely to gain satisfaction in accomplishing their given tasks. Lastly, someone who has developed the main sources of efficacy—personal mastery, understanding the experiences of others, verbal persuasion, and emotional stimulation—has a greater inclination to self-efficacy improvement, leading to enhanced results in their academics and occupational practice.[2]

Previous studies have found that learners' academic self-efficacy (ASE) is highly linked to their performance in academics.[10,11] Furthermore, despite the limited longitudinal research on the association between ASE and educational performance, the most recent study found that academic performance is improved with higher ASE over time and vice versa.[12] The development of positive ASE among graduate students is essential for them to believe that they will be able to attain the goals of their curriculum and degree.[13] That is, in developing their academic motivation and achievement, the belief that they can master their academic activities is important.[14,15] Among many other contributing factors, students' self-efficacy plays a vital part in enhancing academic success. Through this, the students' drive, confidence, self-trust, encouragement, and motivation to complete their academic tasks are facilitated, providing them with a higher chance of passing their tests, which results in their achievement of high grades.[11]

Buffone *et al*. created the Academic Nursing Self-Efficacy Scale (ANSE) to measure self-efficacy in nursing education based on a rigorous literature review.[16] However, even with numerous instruments developed to measure self-efficacy, no research publications have discussed the psychometric methods for an ASE instrument's cross-cultural validation for student nurses in Saudi Arabia. Therefore, it is essential to develop a valid and reliable tool specifically for student nurses in Saudi Arabia and other Arabic-speaking countries to assess and monitor their self-efficacy, which could also indicate the students' mental health status. Moreover, there are few studies on self-efficacy in student nurses' general confidence in their ability to cope with a range of daily assignments and other educational tasks. Therefore, assessing the ANSE's validity and reliability in Arabic and evaluating nursing students' ASE is important. This study also includes testing of the associations between the students' demographics and overall ANSE-A scores.

This study points out that for nursing educators to assist nursing students in carrying out their academic responsibilities, the ANSE may serve as a guide in identifying students with poor ASE. The study results will also enable the creation and implementation of suitable initiatives to assist students in improving their grades. A valid and reliable scale might also help design more effective outcome-based nursing programs. Finally, the findings will serve as a basis for educators to offer students proper training to help them overcome nursing education challenges.

METHODS

This study utilized quantitative and descriptive methods with a cross-sectional design. The research project was approved by Shaqra University's Ethics Review Committee (reference number ERC_SU_2021021). The investigation was carried out from January to July 2022 on one of the campuses of Shaqra University, a nursing university under the Saudi Arabian government. The sample selection was based on four criteria: (1) Saudi nationality, (2) male and female nursing students at any level, (3) 18 years old and above, and (4) willing to join. With the use of convenient sampling, a total of 240 students were invited and qualified to take part in the study, and 200 students decided to participate and were included in the data analysis. This sample size is adequate to conduct analysis to build the instrument's psychometric properties (10 samples for each scale item)[17] because the tool consists of 14 items, and the minimum sample calculation was 140.

Data were collected through an online survey using a Google form. The survey had three parts: (1) study information and consent form; (2) gender, year/level, age, number of absences from classes (theory and practical), GPA (1.00–5.00 scale), and family income (less than 10,000 SAR, 10,000–14,999 SAR, 15,000–19,999 SAR, and 20,000 SAR and above); and (3) the Arabic-translated ANSE-A questionnaire based on Bulfone *et al*.[16]

The tool based on Bulfone *et al*. is a four-item scale that assesses the ASE of nursing students. It consists of 14 items

with four factors: "external emotional management" (four items), "autoregulatory behavior" (four items), "internal emotional management" (three items), and "sociality" (three items). The rating scale is as follows: 1 "Very unconfident," 2 "Slightly unconfident," 3 "Somewhat confident," 4 "Slightly confident," and 5 "Very confident." The reliability of the ASE of Bulfone *et al*. scale is 0.84, and its Cronbach's alpha coefficient is 0.72–0.83. Therefore, it is a useful and trustworthy instrument.[16]

The recommended measures for the cross-cultural translation of the instrument served as a basis for translating the ANSE-A.[17] In Stage I (Initial Translation), two linguists who were native speakers of Arabic independently translated the English text into Arabic. A Saudi nursing instructor who teaches at an institution served as the first translator, while a Saudi translator unfamiliar with the topic under study served as the second translator.

Then, in Stage II (Synthesis of the Translations), the two translators compared and discussed their respective versions of the Arabic translation to arrive at a final translation. In Stage III (Back Translation), following the completion of a unified version, a language specialist unfamiliar with the research subject or the original tool performed a back translation into English. This ensured that the translated version included the same information as the original form.

In Stage IV (Expert Committee), the expert committee created a preliminary translation of the two versions. Five expert panels evaluated the two versions' distinctiveness, experiential value, linguistic meaning, and conceptual equality. They assessed the applicability of every item by means of a four-point Likert scale where the relevance ratings varied from 1 to 4, with 1 being completely irrelevant and 4 being extremely relevant for content validity. In Stage V (Test of the Pre-final Version), 30 nursing students evaluated the pre-final version to ensure it was acceptable and thorough. The students were questioned on the survey items' appropriateness, difficulty, similarity, and vagueness. They determined the questionnaire to be clear, and the committee ultimately approved the form considering the obtained data. Therefore, the final draft was created and evaluated for validity and reliability.

Participants were recruited over the Internet. They were given a short overview of the study, and its significance and objectives were explained. This included the necessity of student participation, student rights, and the voluntary nature of participation. If the students gave their consent to participate, they were requested to proceed to the next step. No identification data was collected to guarantee privacy and confidentiality. Passwords and limited access to the online documents by the authorized researchers were ensured to protect the data, followed by the automatic registration of the completed surveys.

The data analyses for this investigation were calculated using SPSS version 22.0. First, percentage, mean, and SD were utilized for the demographic characteristics of the respondents. Second, we used the item-level content validity index (I-CVI) and scale-level content validity index using an averaging method (S-CVI/Ave) to verify the content validity. According to Polit and Beck (2006), I-CVI and S-CVI/Ave scores of 1 and ≥0.90, respectively, are deemed satisfactory.[18]

Third, Cronbach's alpha was utilized to measure internal consistency. A Cronbach's $\alpha \geq 0.70$ was adequate to ensure reliability.[18] Nunnally and Bernstein (1994) reported that an item-to-total correlation (ITC) of <0.30 or >0.80 may be used as a foundation for the internal structure's validity.[19] Lastly, for the construct validity, before testing the analysis, we applied the Kaiser–Meyer–Olkin (KMO) and Barlett's test of sphericity to determine the suitability of the sample size (KMO value ≥0.60) and applicability of the factor model ($p < 0.05$). The construct validity of the principal component analysis (PCA) was tested using varimax rotation. Factors with a factor loading of >0.40 and an eigenvalue of >1 can demonstrate appropriate construct validity.[20] We applied a t-test and ANOVA to test the association of variables.

RESULTS

Table 1 shows the demographic characteristics of the 200 surveyed pre-registered nursing students. The respondents' average age was 21.38 years (SD = 1.87), and more than half (67.0%) were male. A more significant proportion of the participants were sophomores (41.0%), while 31.5% and 27.5% were juniors and seniors, respectively. Most students reported their parents' monthly income below 10,000 SAR (57.0%). The average number of absences from their theoretical and practical courses was 1.75 days (SD = 1.60) and 1.21 days (SD = 1.24), respectively. The mean GPA was 3.90 (SD = 0.81).

We also tested the associations between the students' demographics and the overall ANSE-A scores. The results revealed a connection between the student's ASE and their gender and GPA. Also, female students (M = 56.35, SD = 8.28) had stronger ASE than male students (53.17, SD = 10.35, $t = -2.34$, $p = .020$). Cohen's D specified A small effect size, which was 0.34. Additionally, there was a marginally positive correlation ($r = 0.17$, $p = 0.017$) between the respondents' GPA and ASE.

The content validity of the ANSE-A was evaluated by expert group members who rated all the 14 items of the scale as either "relevant" or "highly relevant," thereby resulting in the I-CVI of all the items as 1.00 and an S-CVI/Ave equal 1.00, which indicates that the ANSE-A's content validity was excellent at the item and scale levels.

Among the 14 items on the scale in Table 2, the one ranked lowest by the students is "Feeling shame after

making a bad impression in front of the class" (M = 3.52, SD = 1.15), while "Helping a colleague having difficulty in their studies" received the highest mean rating (M = 4.36, SD = 0.98). For the ITC, the lowest value was recorded for "Feeling shame after making a bad impression in front of the class" (ITC = 0.39). In contrast, the highest was recorded for "Avoiding discouraging myself in adversity" (ITC = 0.64). All ITC values were within the acceptable range of 0.30 to 0.80. Additionally, none of the 14 items would result in a 10% increase in the scale's overall Cronbach's alpha when deleted (Cronbach's if the item is deleted range = 0.855–0.867). In reality, removing a scale item will result in a 0.003–0.015 reduction in the overall Cronbach's alpha of the scale.

Over the full scale, Cronbach's alpha was calculated as 0.87. For its factors, the following Cronbach's alpha was revealed: Factors 1, "External emotional management," and 2, "Auto-regulatory behavior," each had 0.74, while Factors 3, "Internal emotional management," and 4, "Sociality," each had 0.76. The computed Cronbach's alpha indicates that the ANSE-A and its four subscales have acceptable internal consistency reliability.

All 14 elements were kept in the Arabic version and recorded in PCA with Varimax rotation based on the ITC values and Cronbach's alpha if the item was eliminated. Bartlett's test of sphericity was significant (χ^2 (91) = 1,024.54, $p < 0.001$), which demonstrates that the factor model is adequate for our dataset. KMO was calculated as 0.85. Consequently, the KMO and Bartlett's test of sphericity confirm the validity of moving further with the PCA.

Table 3 shows the four distinct components extracted from the scale with a total explained variance of 64.86%. With an Eigenvalue of 5.28, the first component was responsible for 37.69% of the total explained variation. Factor 2 explained 10.40% of the variance (Eigenvalue = 1.46), while Factors 3 and 4 contributed 9.58% (Eigenvalue = 1.34) and 7.19% (Eigenvalue = 1.01), respectively. Six items (items 3, 4, 8–11) loaded in Factor 1, while five (items 4, 5–8), four (items 1–4), and three items (items 12–14) loaded in Factors 2, 3, and 4, respectively.

Three items loaded in either 2 or 3 of the factors. Item 3 loaded in Factors 1 and 3; Item 4 loaded in Factors 1, 2, and 3; and Item 8 loaded in Factors 1 and 2. These factors were not removed from the scale because their removal would decrease the scale's overall Cronbach's alpha. Accordingly, we chose to keep Item 3 in Factor 3, Item 4 in Factor 2, and Item 8 in Factor 1. This decision was made because these items were more suited to the construct being measured by those factors and conformed to the original version of the scale's factor structure. Following the original version, Factor 1 was labeled "External emotional management," Factor 2 was named "Auto-regulatory behavior," Factor 3 was labeled "Internal emotional management," and Factor 4 was named "Sociality."

DISCUSSION

The validity of the tool and its dependability are highlighted in this study. The tool must be tested for its validity and reliability to be recognized as an instrument with excellent psychometric properties.[20] According to the results of the analysis, the ANSE-A was both valid and reliable to measure the ASE of student nurses in Arabic-

TABLE 1. Demographic characteristics of the participants and their association with academic self-efficacy (N = 200)

Variable	N	%	Academic Self-efficacy		
			Mean (SD)	Correlations / Statistics	*p*
Gender					
Male	134	67.0	53.17 (10.35)	$t = -2.34$	0.020*
Female	66	33.0	56.35 (8.28)		
Year/level					
2nd year	82	41.0	54.67 (9.84)	$F = 0.19$	0.831
3rd year	63	31.5	53.67 (9.01)		
4th year	55	27.5	54.18 (10.73)		
Parent's monthly income					
Below 10,000 SAR	114	57.0	54.19 (9.49)	$F = 1.28$	0.339
10,000–14,999 SAR	37	18.5	55.05 (9.35)		
15,000–20,000 SAR	28	14.0	51.57 (12.57)		
Above 20,000 SAR	21	10.5	56.43 (7.86)		
		Range			
Age		18–32	21.38 (1.87)	$r = 0.01$	0.943
No. of absences					
Theory		0–8	1.75 (1.60)	$r = 0.04$	0.580
Practical		0–5	1.21 (1.24)	$r = 0.05$	0.512
GPA		0–5	3.90 (0.81)	$r = 0.17$	0.017*

*Significant at 0.05 level

TABLE 2. Item mean, corrected item-total correlations, and Cronbach's alpha if item deleted for the Academic Self-Efficacy scale-Arabic version (N = 200)

Item	Mean (SD)	CITC	Cronbach's alpha if the item is deleted	Cronbach's alpha for each domain
Domain 1: External emotional management				
Item 8. Do not feel spiritless when you are criticized	3.85 (1.14)	0.57	0.858	0.74
Item 9. Feeling shame after making a bad impression in front of the class	3.52 (1.15)	0.39	0.867	
Item 10. Overcoming the embarrassment of having made a "gaffe" in front of a person whose judgment you care about a lot	3.79 (1.12)	0.60	0.857	
Item 11. Feeling shame when your weaknesses are highlighted in front of the class	3.85 (1.13)	0.55	0.859	
Domain 2: Auto-regulatory behavior				
Item 4. Resisting peer pressure to do something that risks getting you into trouble	3.91 (1.18)	0.62	0.62	0.74
Item 5. Resisting the temptation to skip the lesson if you feel bored	3.75 (1.26)	0.48	0.863	
Item 6. Avoiding the insistence of friends who ask you to do something that you think would be better to avoid	4.10 (1.11)	0.61	0.856	
Item 7. Avoiding committing transgressions even when the risk of sanction is minimal	3.97 (1.18)	0.53	0.860	
Domain 3: Internal emotional management				
Item 1. Controlling anxiety in the face of a problem	3.53 (1.28)	0.48	0.864	0.76
Item 2. Keeping calm during an exam	3.83 (1.21)	0.47	0.864	
Item 3. Avoiding discouraging myself in adversity	3.71 1.14)	0.64	0.855	
Domain 4: Factor 4: Sociality				
Item 12. Ensuring me the help of other students when necessary	3.89 (1.14)	0.46	0.864	0.76
Item 13. Helping a colleague having difficulty in their studies	4.36 (0.98)	0.55	0.860	
Item 14. Helping to create a good atmosphere among students	4.19 (1.04)	0.45	0.864	
Overall Cronbach's alpha				0.87

TABLE 3. Results of the principal components analysis for the Academic Self-Efficacy scale-Arabic version (N = 200)

Item	Factor 1 External emotional management	Factor 2 Auto-regulatory behavior	Factor 3 Internal emotional management	Factor 4 Sociality
9	0.788			
10	0.732			
11	0.702			
8	0.531	0.468		
7		0.776		
5		0.709		
6		0.603		
2			0.815	
1			0.789	
3	0.409		0.625	
4	0.415	0.419	0.466	
14				0.814
13				0.805
12				0.708
Eigenvalue	5.28	1.46	1.34	1.01
Variance explained (%)	37.69	10.40	9.58	7.19
Cumulative variance explained (%)	37.69	48.09	57.67	64.86

speaking countries, specifically Saudi Arabia. The tool may be used to assess the ASE of student nurses with consistency and accuracy. Saudi Arabia's main language is Arabic; thus, the English version of the ANSE tested by Bulfone *et al*. should be examined for its validity and reliability to take on context-specific, operational definitions that may require modification cross-culturally. The validity of ANSE-A was first established by demonstrating its content and construct validity. The experts appraised the applicability of all items, and the tool presented excellent content validity. Therefore, the results indicated that the scale items were suitable for Arabic culture and that the scale appropriately measured the content and had content validity. The outcome was consistent with the psychometric analysis conducted among student nurses.[16]

The KMO and Barlett's tests of sphericity values verify that the sample size was acceptable, and that the factor model was valid. Using the PCA, four distinct factors were identified in the ANSE-A: (1) external emotional management, (2) autoregulatory behavior, (3) internal emotional management, and (4) sociality. The student nurses' ANSE had a jointly explained variance of 64.86%, indicating excellent construct validity.[22] These four variables are comparable to the original validation.[16] However, three factors were split-loaded on three different factors. Item 3 was placed in Factors 1 and 3, Item 4 was loaded in 3 Factors, and Item 8 was loaded in Factors 1 and 2. Nunnally and Bernstein argued that the split-loaded items should be kept due to the significant connections between these components.[19] Additionally, this is possible with the hypothesis that it is the variable's latent nature.[23] Item 3 ("Avoiding discouraging myself in adversity") is an internal reaction with the kind of mentality that is not something that we should foster in ourselves. Therefore, students should be enlightened about how facing adversities in life will become an integral part of their success. For this reason, this item deals with Factor 3 (internal emotional management) rather than Factor 1 (External emotional management). The students' capacity to comprehend and exert control over their conduct and responses to feelings and events in their surroundings is addressed in Item 4 ("Resisting peer pressure to do something that risks getting you into trouble"). With this consideration, it is loaded under Factor 2 (auto-regulatory behavior) rather than the other factors. Finally, Item 8 ("Do not feel spiritless when you are criticized") deals with being able to fight a lack of courage and still feeling motivated when being denounced. Therefore, this item should be incorporated under Factor 1 (External emotional management). The items mentioned were similar to those of the original version of the tool.

Previous studies have shown that reducing violent and aggressive behavior in adolescents requires a high level of self-efficacy.[24] Four items make up Factor 1 (external emotional management), including "containing shame after making a bad impression in front of the class," "Overcoming the embarrassment of having made a gaffe with a person to the judgment of which you care a lot," "dominating shame when your frailties have highlighted in front of the class," and "do not be spiritless when you are criticized." According to Restubog *et al*., effective emotion regulation is essential for minimizing unpleasant feelings and improving well-being.[25] This factor is consistent with the assertions that emotional self-efficacy is a person's subjective assessment of their emotional competence, which includes the capacity to express positive emotions like satisfaction, joy, and liking and modulate negative emotions like anger, anxiety, and sadness.[24,26]

Factor 2 (auto-regulatory behavior) has four items, namely, "avoiding committing transgressions even when the risk of sanction is minimal," "resisting the temptation not to go to the lesson if you feel bored," and "avoiding the insistence of friends who ask you to do something that you think would be better to avoid" and "resisting the pressure of friends for doing something that risks getting you into a trouble." Adolescents regulate their emotions differently in daily life because of various capacities and differing perspectives on those capacities. When confronted with upsetting or stressful conditions, it is possible for a person to feel confident in their capacity to control their emotions but actually be unable to do so. However, it is more challenging for someone to control their emotions if they do not believe they can. In the end, the belief in one's ability to regulate their emotions contributes to their psychological well-being.[27] Experiencing negative emotions may make that belief less true, undermining the regulatory emotional self-efficacy perception.[28]

Emotional skills are crucial to improving self-efficacy.[29] The Factor 3 items are internal emotional management, including "keeping calm during an exam," "controlling anxiety in front of a problem," and "avoiding discouraging myself in adversity." This factor emphasizes paying attention to the ideas and feelings occurring at the moment and also embracing and not passing judgment on them. As a result, a person's emotional efficacy will be positive, and they will be able to manage negative emotional efficacy.[30,31]

Factor 4 (Sociality) consists of "helping in creating a good atmosphere among students," "helping a colleague with difficulty in the study," and "ensuring the help of other students when necessary." In general, social support directly affects self-efficacy.[32–34] In a study conducted with nursing students, social support had a meaningful effect on their self-efficacy.[35] Consequently, it is implied that when nurses perceive that they are receiving help from others, they may feel that their work is valuable and gain more confidence.[32]

This study's internal consistency examination reveals that the ANSE-A is acceptable, indicating that each item is coherent. This outcome is consistent with the reported Cronbach's alpha in the scale's initial validation trial.[16] The Cronbach's alpha value exceeded expectations. The results of the four variables were very consistent. Thus, the ANSE-A is reliable for evaluating Saudi nursing students' ASE.

The gender and GPA of students were related to their ASE. In terms of gender disparities in nursing programs, female learners had higher self-efficacy than male learners.[28,36,37] In an Iranian study, female medical and dental students reported stronger self-efficacy than male students.[38] However, this was in contrast to Ribeiro *et al*.'s study that found male nursing students to have greater levels of self-efficacy than female students.[39] Meanwhile, Ister's study of nursing students found that male and female students' self-efficacy scores were comparable.[40]

Self-efficacy has long been considered a significant aspect of predicting educational achievement.[12,41] There is a weak positive correlation between ASE and GPA. If self-efficacy is low, students will find it difficult to perform tasks under similar conditions.[42] If self-efficacy is high, they are more likely to persist in learning.[43] In conclusion, the higher a student's level of self-efficacy, the higher their academic grade.[38]

Despite its contribution to the nursing field's knowledge, this study has some limitations. First, there is an issue with the generalization of findings related to the sampling technique used, which is convenient sampling. Conversely, the study's sample size was adequate to measure the reliability and validity of the tool. Second, content validity and PCA were used to measure the validity of the ANSE-A. Other validity measurements were not used (convergent and divergent validity) because of the lack of items in the Arabic version of the scale that can be used to check opposite or similar concepts. Therefore, the researcher recommends that future studies conduct additional validity tests to enhance the results of the current study. Third, since Cronbach's alpha was utilized to gauge the internal consistency of the tool, other reliability test methods (i.e., stability reliability) should be performed.

CONCLUSIONS

Based on the results of this study, the Arabic version of the ANSE is a valid and reliable instrument to measure the ASE of nursing students concerning external emotional management, auto-regulatory behavior, internal emotional management, and sociality. The outcomes suggest that the instrument has suitable content validity and is applicable and significant within the context of Saudi Arabia. The results also support the factors of the instrument, which are consistent with the original version. The instrument's construct validity was acceptable in assessing the ASE of Saudi nursing students. The tool also displayed acceptable reliability, as supported by Cronbach's alpha. Therefore, this tool can be used by future researchers in testing the validity and reliability of other tools with similar constructs in the Arabic language.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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Risk Factors Associated with Occupational Stress among Malaysian Construction Professionals

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Risk Factors Associated with Occupational Stress among Malaysian Construction Professionals

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Abstract

Background: Construction industries that focus on project-based nature, pressure, and long hours may lead to job-related stress among workers. In many emerging nations, robust economic growth plans generate occupational depression, anxiety, and stress among construction industry personnel. This study aims to determine the relationship between these items and the risk factors (demographic) among Malaysian construction professionals.

Methods: A cross-sectional study was carried out among 173 Malaysian construction professionals. A DASS-21 questionnaire is used to survey eligible respondents.

Results: Findings show that construction professionals have a high level of stress (54.9%), anxiety (48.5%), and depression (37%). Gender is significantly associated with stress (p = 0.000) and depression (p = 0.000). In turn, stress (p = 0.038), anxiety (p = 0.000), and depression (p = 0.001) all demonstrate a significant relationship with health status

Conclusions: Health status is the risk factor most significantly associated with occupational stress. Given the findings, construction managers can help protect their employees and their mental health by promoting a healthy workplace through stress management and social activities.

Keywords: anxiety, construction professionals, depression, occupational stress, risk factors, stress

INTRODUCTION

Construction in Malaysia has a fatality rate of 6.30 per 100,000 employees, which remains the highest of all industries.[1] Construction has a longstanding experience of being highly demanding.[2] This industry has several characteristics known as three "Ds" (Dirty, Difficult, and Dangerous), which distinguish it from other sectors and emphasize the importance of professional involvement. In addition, evidence suggests that the industry activities engage an increasing number of people with various specializations.[3] The constant expansion in the complexity of work and the growing need for increased productivity have become typical in the construction sector, causing a demanding environment for meeting project schedules, quality goals, and cost targets. Thus, construction personnel are constantly challenged by a competitive environment and complex tasks. In such conditions, construction professionals such as architects, project managers, quantity surveyors, and engineers are forced to work under pressure.[4] Given the Industrial Revolution 4.0 (IR4.0), stress at work has persisted in Malaysia's construction sector, even though technology advancements are being used to help ease employee-related duties.[5] As a result, occupational-related depression, anxiety, and stress have become common among construction professionals. The Chartered Institute of Building reported that 68% of construction professionals suffer from depression, anxiety, and stress.[6]

Previous literature has shown that depression, anxiety, and stress may all be related to personal factors,[2] such as age, gender, income, marital status, occupation, and personality traits that can trigger psychological state symptoms. Anxiety is described as a person's fear of being unable to manage or achieve the intended outcome in upcoming events.[7] Beck defines depression as cognitive biases and negative self-schemas that maintain the unfavorable triad, a negative and irrational view of ourselves, our future, and the world around us.[8] For sufferers of depression, these thoughts occur automatically and are symptomatic of depressed people.[8] Stress is defined as a non-specific response of the body to any demand for change.[9]

In the construction industry, work stressors include negative job environments, unsupportive corporate

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culture, unsupportive managers and coworkers, workplace harassment and discrimination, the urge to demonstrate skills, and work pressures.[6,7] The hot temperature at the construction site, lack of food, poor communication, inadequate staffing, and job demand factors such as excessive work, ambitious deadlines, and pressure are potential work stressors.[6,10] While these stressors are mainly job-related, personal factors play a role in the occurrence and severity of mental conditions among construction industry professionals.[2] According to occupational psychology research, personal risk factors such as age, gender, marital status, income, and occupation affect work-related psychological diseases.[2] Furthermore, Gómez-Salgado *et al*. found that age, inappropriate safety equipment and culture, high workload and responsibilities, financial situation, and lack of knowledge cause stress among construction workers.[11]

According to recent studies, construction professionals are more prone to experience negative pressure at work, which severely impacts their health and productivity.[12] Such pressure arises when employees face an imbalance between the demands, stressors, or challenges they encounter and the available resources or support to manage these issues adequately. This imbalance can cause unfavorable outcomes for employees and the overall work atmosphere. Work-related stressors in the construction industry may adversely affect individual job performance, decision-making skills, and behavior.[13,14] According to Ratanasiripong *et al*., personal characteristics such as age, smoking, work roles, working hours, educational level, sleep, and income significantly correlate with depression, anxiety, and stress.[15] These risk factors are typically neglected and given less attention than work-related concerns.[2]

Thus, the present study aims to determine the relationship between occupational depression, anxiety, and stress and the risk factors (demographic) among Malaysian construction professionals. Quantity surveyors, site supervisors, safety and environmental officers, civil engineers, and architects are the main research population. The findings could improve the construction industry, particularly construction professionals and management, by providing appropriate guidance, coping skills, and counseling to encourage greater transparency in expressing occupational stress.

METHODS

The University Kebangsaan Malaysia Research Ethics Committee has approved the proposed research methodology (JEP-2022-785). The confidentiality of participants was ensured through the non-disclosure of their names or any personal information in any presentation or publication.

The cross-sectional study was carried out among Malaysian construction professionals who were chosen using a purposive sampling method. Those who have worked in Malaysia for over a year, such as quantity surveyors, site supervisors, safety and environment officers, civil engineers, and architects, are eligible to participate in this study. This criterion is in line with the study done by Inayat and Jahanzeb Khan, where workers with one year of experience and above are selected as respondents.[16] Given the Coronavirus disease 2019 (COVID-19) outbreak in Malaysia, the self-administered questionnaire was distributed online, and data collection of responses took approximately two months. The questionnaire was prepared in a Google Form to facilitate online dissemination and included the consent form and an explanation of the study's purpose and assurances of confidentiality. The representatives from the targeted population were contacted regarding this survey and data collection. The online survey link was shared with targeted construction professionals through social media such as WhatsApp, Facebook, and email. A simple reminder was sent to unresponsive participants one week after the initial distribution to maximize response rates. Then, the online survey response was used to check the number of responses among targeted respondents. Then, the researchers resent the online survey link and instructions to the target respondents via the same social media. The sample size was determined by using the sample-to-variable ratio method. Given that the use of 15–20 observations per independent variable 17 is strongly advised, and thus this study used the ratio of 15:1. Five independent variables are examined, including gender, monthly salary, health status, smoking, and exercise routine. Regarding the above statement, the sample size is ideally 75. However, considering other factors that can cause the data to be invalid, the number of 173 samples was evaluated.

The questionnaire consisted of two sections, namely, sociodemographic risk variables (11 items) and DASS-21 (21 items). The questions were prepared in both English and Malay for the convenience and understanding of respondents, as the industry workers widely speak both languages. The survey was sent in both languages for validation by two experts. Then, a pilot study was carried out among 31 Malaysian construction professionals to assess the survey's internal consistency. Results showed that Cronbach's Alpha is 0.946, indicating a good score. However, such data were excluded from the actual study, given its purpose to assess the feasibility of a strategy that can be used in larger-scale research.[18]

Based on previous research, gender, age, marital status, education level, monthly wage, job position, years of working experience, daily working hours, health status, smoking status, and exercise routine were constructed as variables.[15] Using a 4-point Likert scale ranging 0–3, the DASS-21 instrument was developed to assess self-reporting

on occupational stress over the previous week[19]. The rating scale was scored as follows: 0 indicates "did not apply to me at all"; 1 indicates "applied to me to some degree or some of the time"; 2 indicates "applied to me to a considerable degree or a good part of the time"; and 3 indicates "applied to me very much or most of the time."

The data were analyzed using Statistical Packages for Social Sciences version 26.0. The sociodemographic risk factors were calculated in terms of frequency and proportion. The result of DASS-21 is categorized into three: (1) depression, (2) anxiety, and (3) stress. Each primary factor has seven sub-items, yielding a total of 21. The association was determined using the Chi-square test after the data were evaluated for nonnormal distribution using the Kolmogorov-Smirnov test. The chi-square test was assessed using a $p < 0.05$ level of significance.

RESULTS

This study sampled 173 construction professionals, mostly safety and environmental officials (29.5%) and civil engineers (26.6%). Among the respondents, males (56.1%) exceeded females (43.9%). Most respondents are between the ages of 21 and 30 (72.8%). Regarding educational level, 43.9% had earned a diploma, 41.0% had earned a degree, 7.5% attained a master's degree, 6.4% were high school dropouts, and 1.2% attained doctorates. The respondents earned an average of RM3000 (61.3%), had a work experience of 1–2 years (39.9%), and worked more than eight hours (51.4%) every day. Regarding health, 95.4% reported being in good health, 76.3% as nonsmoking, and 47.4% exercising monthly. For marital status, approximately 80.3% were not married, while 19.7% were married. The results are presented in Table 1.

The DASS-21 scores were classified into normal, mild, moderate, severe, and extremely severe, as indicated in Table 2. Most respondents (63.0%) reported having an average level of depression, while the others reported mild to extremely severe symptoms. The proportion of respondents with normal and abnormal anxiety was significantly different, with 51.4% reporting normal anxiety and 48.5% reporting anxiety ranging from light to extremely severe. Nearly half of the respondents (45.1%) reported having a typical stress level whereas 54.9 % reported having a mild to extreme degree of stress.

Furthermore, Table 3 indicates that five out of 11 risk variables were chosen to determine the significant values based on the obtained data. These five risk factors were selected because they were found to have the strongest association with previous literature.[11,15,20,21] The present study found that the majority of the respondents who had suffered from depression (23.0%), anxiety (31.2%), and stress (31.2%) were male. A significant proportion of respondents with a monthly income of RM3000 reported suffering from depression (23.7%), anxiety (30.0%), and stress (35.3%). Despite their good health, respondents suffered from depression (32.4%), anxiety (45.1%), and stress (51.4%). Most nonsmokers (28.9%) were suffering from depression, anxiety (39.8%), and stress (43.9 %).

TABLE 1. Sociodemographic among professionals in construction industries (N = 173)

Variables	N (%)
Gender	
Male	97 (56.1)
Female	76 (43.9)
Age (in years)	
< 21	23 (13.3)
21 – 30	126 (72.8)
31 – 40	20 (11.6)
41 – 50	4 (2.3)
> 50	0 (0.0)
Marital status	
Unmarried	139 (80.3)
Married	34 (19.7)
Education level	
High school	11 (6.4)
Diploma	76 (43.9)
Bachelor's Degree	71 (41.0)
Master's Degree	13 (7.5)
Doctor of Philosophy	2 (1.2)
Monthly salary	
RM 3000	106 (61.3)
RM 3000–5000	44 (25.4)
RM 5001–7000	11 (6.4)
RM 7001– 9000	5 (2.9)
RM 9001–11,000	2 (1.2)
> RM11,001	5 (2.9)
Working position	
Architects	26 (15.0)
Safety & Environment	51 (29.5)
Civil Engineers	46 (26.6)
Quantity Surveyors	27 (15.6)
Site Supervisor	23 (13.3)
Experience working at construction site	
<1 year	50 (28.9)
1–2 years	69 (39.9)
3–5 years	41 (23.7)
6–10 years	9 (5.2)
>10 years	4 (2.3)
Daily working hour	
<8 hours	84 (48.6)
≥8 hours	89 (51.4)
Health status	
Good	165 (95.4)
Poor	8 (4.6)
Smoking status	
Smoker	28 (16.2)
Former Smoker	13 (7.5)
Non-Smoker	132 (76.3)
Exercise routine	
Daily	17 (9.8)
Weekly	74 (42.8)
Monthly	82 (47.4)

TABLE 2. Depression, anxiety, and stress levels of the 173 respondents

Level	Depression N (%)	Anxiety N (%)	Stress N (%)
Normal	109 (63.0)	89 (51.4)	78 (45.1)
Mild	23 (13.3)	26 (15.0)	33 (19.1)
Moderate	14 (8.1)	28 (16.2)	28 (16.2)
Severe	14 (8.1)	21 (12.1)	21 (12.1)
Extremely severe	13 (7.5)	9 (5.2)	13 (7.5)

TABLE 3. Sociodemographic risk factors among professionals in the construction industry

Variables	%	Depression (%)	Anxiety (%)	Stress (%)
Gender				
Male	56.1	23.0	31.2	31.2
Female	43.9	13.9	17.4	17.3
Monthly salary				
RM3000	61.3	23.7	33.0	35.3
RM 3000–5000	25.4	9.3	9.8	12.1
RM 5001–7000	6.4	2.3	5.2	4.5
RM 7001– 9000	2.9	1.2	0	1.2
RM 9001–11000	1.2	0	0	0
>RM11001	2.9	0.6	0.6	0.6
Health status				
Good	95.4	32.4	45.1	51.4
Poor	4.6	4.6	3.5	3.5
Smoking status				
Smoker	16.2	4.6	4.0	6.4
Former smoker	7.5	3.5	4.6	4.6
Non-smoker	76.3	28.9	39.8	43.9
Exercise routine				
Daily	9.8	2.3	2.3	3.5
Weekly	42.8	11.6	20.2	20.8
Monthly	47.4	23.13	26.0	30.6

TABLE 4. Association between occupational depression, anxiety, and stress with the risk factors among professionals in the construction industry

Variables	Depression p^a	Anxiety p^a	Stress p^a
Gender	0.237	0.004*	0.000*
Monthly salary	0.851	0.351	0.547
Health status	0.001*	0.000*	0.038*
Smoking status	0.397	0.062	0.103
Exercise routine	0.104	0.391	0.110

*Significant at $p<0.05$ (2-tailed), [a] Chi-square analysis

Those who frequently do their exercise routines once a month also suffered from depression (23.13%), anxiety (26.0%), and stress (30.6%).

The chi-square test was used to determine the association between occupational stress (depression, anxiety, and stress) and risk factors, as indicated in Table 4. Significant associations were recorded between gender and stress (p = 0.000) and between gender and anxiety (p = 0.004). Following that, significant associations were also recorded between health status and depression (p = 0.001), anxiety (p = 0.000), and stress (p = 0.038).

DISCUSSION

The findings show high levels of stress, anxiety, and depression among the respondents. In addition, significant relationships are found between gender and stress, and between gender and anxiety. Stress, anxiety, and depression each demonstrate a significant relationship with health status.

The current results clearly show that the construction industry in Malaysia has more male professionals than females. Even though diverse workplaces are more productive and profitable, the construction industry

continues to be one of the most male-dominated sectors.[5,22] Males are more likely to suffer from depression, anxiety, and stress, suggesting that they are more influenced by working conditions than females. Moreover, because of their regular load of high-risk responsibilities, men are also more stressed than women.[23]

Notably, this study establishes the relationship between gender and mental conditions such as stress and anxiety. Male dominance in the industry may also be vulnerable.[24] The lack of natural female characteristics such as calm, comforting, and polite behavior may add value to the industry's support structure, thereby reducing several difficulties.[2,25] One reason for not handling stress is identified as the male-centric "macho" approach toward getting the job done. This reason is supported by the view that females are more prone than males to participate in a "tend-and-befriend" response to stressors whereas males are likelier to display a "fight-or-flight" response.[25–27] Admitting to work-related stress is regarded as a show of weakness, and as a result, worry, and anxiety are rarely expressed or acknowledged. Stakeholders in the construction sectors have only seen a small number of cases involving mental illnesses, and really do not keep track of sick leave, causing difficulites in the accurate analyses the current situation.[27]

According to the data gathered, low monthly wages contribute to the depression, anxiety, and stress among construction professionals. Their financial pressures include price inflation, financial stability in the future, and student loan debts.[22] This result can indicate that financial management and salary issues contribute to emotional and mental stress. Certain risk factors are more apparent in females. The reason is that the male connection is a component of manhood and being a woman in such an environment involves a delicate balancing act between efficiently expressing masculinity and discovering new methods to do the same tasks. As a result of these issues, women in the construction industry are less satisfied with their wages and job security.[5] However, chi-square analysis shows no association between monthly salary and occupational stress (depression, anxiety, and stress) among the respondents, possible because professionals in the construction industry are entitled to higher salaries and benefits than regular employees. Workers in the middle and upper ranks of this industry earn more and advance at a faster rate than craftsmen.[2]

In addition, the COVID-19 outbreak provided another challenge to the construction industry, as revealed by several factors—a lack of a safe work environment, heavy workloads, family situations, and concerns about job stability—that frequently contribute to anxiety, depression, and even suicide.[28] A labor shortage and a multiplicity of regulations to minimize viral spread have affected the number of workers permitted in an area, how staff performs their responsibilities, and how project managers view the working environment.[29,30] The lack of a safe working environment results in a stressful working environment and emerging organizational challenges.[30] The current results from chi-square analysis show a significant association between health status and depression, anxiety, and stress. Among the construction personnel, the most common health issues were headaches, eyestrain, stress, and musculoskeletal disorders (MSDs).[27] The listed health problems are signs of stress. The long hours in the construction industry have resulted in poor eating and sleeping habits, which can contribute to stress.[19] Consequently, sleep problems are associated with fatigue, for which depression is a significant predictor.[31]

The continuous poor condition of mental health secretes stress-related hormones that causes deterioration in the body's general level of biological functioning.[3] Therefore, depression, anxiety, and stress can affect health conditions over time. Construction workers have also resorted to exercising as an emotion-focused method to manage stress on a regular basis.[3,31]

The limitation of this study is this study only measured the depression, anxiety, and stress among Malaysian construction professionals. However, the actual depression, anxiety, and stress were not measured using clinical diagnosis. Moreover, the current health status was determined based on the respondents' perceptions of general health and not through clinical diagnosis. Meanwhile, the risk factors associated with occupational stress only focused on gender, monthly salary, health status, smoking status, and exercise.

Future research is required to further explore the health status issues, such that the medical condition does not become a contributory factor of stress at work. In addition, gender differences also need to be examined due to significant biological differences that are observed in the occurrence of stress and anxiety among respondents. The strategy of support has a noticeably higher effect on levels of job stress among women than men, because males, and females react and respond differently to stress and anxiety. In addition, recognizing, and understanding these gender-specific factors can help tailor support and interventions more effectively, thereby promoting the well-being, and mental health for all employees. Workplace intervention must be accomplished through communication about the professionals' mental conditions. Individual coping techniques, particularly emotional motion-focused strategies, can be utilized to manage concerns that must be addressed immediately following the occurrence of stressors. Problem-focused coping seeks to resolve pressing issues or mitigate their negative consequences, hence lowering levels of depression, anxiety, and stress among construction professionals.

CONCLUSIONS

The current findings indicate that most respondents experience a normal degree of depression, anxiety, and stress. Almost half of the construction professionals have experienced depression, anxiety, and stress in varying degrees of severity. The construction professional must recognize how to cope with depression, anxiety, and stress, including the warning signs, and know the methods to relieve stress such as through healthy eating and exercise. By acknowledging and taking proactive steps to address these issues, employers can create a more supportive and healthier work environment for construction workers. The steps may include providing access to mental health resources, promoting work–life balance, offering stress management programs, and fostering a workplace culture that prioritizes employee well-being. These levels are linked to various risk factors identified in this study. Thus, construction managers can help to protect their employees' mental health by promoting a healthy workplace.

CONFLICT OF INTEREST

No conflicts are declared.

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Prediction of Factors for Patients with Hypertension and Dyslipidemia Using Multilayer Feedforward Neural Networks and Ordered Logistic Regression Analysis: A Robust Hybrid Methodology

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Abstract

Background: Hypertension is characterized by abnormally high arterial blood pressure and is a public health problem with a high prevalence of 20%–30% worldwide. This research combined multiple logistic regression (MLR) and multilayer feedforward neural networks to construct and validate a model for evaluating the factors linked with hypertension in patients with dyslipidemia.

Methods: A total of 1000 data entries from Hospital Universiti Sains Malaysia and advanced computational statistical modeling methodologies were used to evaluate seven traits associated with hypertension. R-Studio software was utilized. Each sample's statistics were calculated using a hybrid model that included bootstrapping.

Results: Variable validation was performed by using the well-established bootstrap-integrated MLR technique. All variables affected the hazard ratio as follows: total cholesterol (β_1: −0.00664; $p < 0.25$), diabetes status (β_2: 0.62332; $p < 0.25$), diastolic reading (β_3: 0.08160; $p < 0.25$), height measurement (β_4: −0.05411; $p < 0.25$), coronary heart disease incidence (β_5: 1.42544; $p < 0.25$), triglyceride reading (β_6: 0.00616; $p < 0.25$), and waist reading (β_7: −0.00158; $p < 0.25$).

Conclusions: A hybrid approach was developed and extensively tested. The hybrid technique is superior to other standalone techniques and allows an improved understanding of the influence of variables on outcomes.

Keywords: dyslipidemia, hypertension, multilayer feedforward neural networks, ordinal logistic regression

INTRODUCTION

High blood pressure, or hypertension, is a well-known, important public health chronic disease due to its concomitant risks for cardiovascular diseases, such as stroke and coronary heart disease (CHD).[1–3] Hypertension has been identified as a major risk factor leading to mortality and is a leading contributor to disability-adjusted life years.[4] According to studies on the clustering of the cardiac disease burden in the Asia–Pacific region, approximately 40% of adults over 25 have a clinical diagnosis of hypertension, resulting in more than 9 million fatalities.[5,6] Hypertension is responsible for approximately 7.4 million deaths from CHD and 6.7 million deaths from stroke.[5,7] Studies conducted across India have provided evidence of the rapid spread of the hypertension epidemic. According to the Indian National Nutrition Monitoring Bureau, which keeps track of the nutritional status of the people in the nine states of India, 25% of rural adults (aged 18 and over) have been diagnosed with hypertension.[8] Likewise, according to the NCD Risk Factor Collaboration's research on global blood pressure trends between 1975 and 2015, which comprised 1479 population-based studies, the prevalence of hypertension in adults rose from 594 million in 1975 to 1.13 billion in 2015.[9] Furthermore, the WHO predicted that by 2025, nearly 1.5 billion people (or 29.2% of the world's population) will have hypertension, up from the approximately one billion adults who had it in 2000.[10] In China, over 180 million people had hypertension in 2000 and another 100 million are projected to have this condition by 2025. Over 40% of the 1.13 billion adults with hypertension in 2015 resided in Asia, with China accounted for 226 million of these cases.[11] Worldwide, the prevalence of hypertension varies, with rates as low as 5.2% in rural North India and as high as 70.7% in Poland.[10] Blood pressure varies even within communities within the same nation, depending on the level of economic development and wealth.[10] In economically developed countries, between 20% and 50% of people have

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hypertension.[12] In the Asia–Pacific region, the prevalence of hypertension varies, ranging from 5% to 47% in men and from 7% to 38% in women.[5] A meta-analysis by Soo *et al*. demonstrated that the prevalence of hypertension in Malaysia is 29.7%.[13]

Analyzing the association of hypertension and cardiovascular diseases shows that patients with prehypertension are at 1.5 times higher risk of developing cardiovascular diseases than those with normal blood pressure.[14] The Framingham Heart Study cohort's 34-year follow-up revealed that the risk of people with higher blood pressure for congestive heart failure is twice that of those with lower blood pressure.[15] Some risk factors, such as age, sex, race, physical activity, and socioeconomic class, have been linked to hypertension. People older than 60 years old account for the vast majority of cases of uncontrolled hypertension.[16] Additionally, anthropometric indices of obesity, such as waist:hip ratio and body mass index, have been linked to hypertension in population studies.[17] In the Framingham Study, excess body fat was linked to 70% of new cases of hypertension.[15] Of the known risk factors for primary hypertension, age, gender, and genetics cannot be changed. In contrast, the majority, including smoking, drinking, unhealthy diet, physical inactivity, excess weight, and obesity, can be effectively controlled.[18] In general, hypertension, particularly uncontrolled hypertension, is associated with an increased risk of cardiovascular death.[18]

Dyslipidemia, now referred to as hyperlipidemia, pertains to abnormal alterations in body composition, particularly in body fat and lipid profiles. Diabetes mellitus is linked to dyslipidemia and is characterized by reduced levels of high-density lipoprotein cholesterol, elevated plasma triglycerides, and increased levels of small dense particles of low-density lipoprotein cholesterol.[10,19] It is associated with lipid abnormalities because insulin resistance affects critical enzymes and pathways involved in lipid metabolism.[20] Furthermore, the lipid molecules in diabetic dyslipidemia have been proposed to be atherogenic. This situation indicates that even normal lipid levels may be more atherogenic in diabetics than in nondiabetics. The link between atherosclerosis and dyslipidemia is well established. Diabetes-related hyperglycemia, obesity, and insulin changes all hasten the progression of atherosclerosis.[21]

Machine learning in the medical field has created new techniques for the early prediction of hypertension. Neural networks have proven to be a powerful tool and shown great results in disease prediction.[22] Previous research has investigated the use of anthropometric, demographic, and lifestyle indices as estimators for hypertension with mixed results.[23] Therefore, this research gap can be reasonably addressed by identifying the association of selected variables with hypertension and the clinical benefit of the developed models. Multilayer perceptron with ordinal regression models could serve as an essential tool assisting health professionals because it uses clinically relevant factors. The objectives of this research include investigating the variables that are associated with hypertension, developing a feedforward neural network model with ordinal regression activators and R syntax for future researchers, and analyzing the reliability of hypertension prediction using mean squared error calculation. This programming is expected to enable researchers to obtain optimal decision-making outcomes in the future.

METHODS

Data collection

A total of 1000 data entries were collected from the Hospital Universiti Sains Malaysia (USM). This study received approval from the USM Research Ethics and Human Research Committee (USM/JEPeM/16050184). The patient's privacy and medical condition were protected. Several variables were recorded. They included hypertension, total cholesterol, diabetes status, diastolic reading, height, CHD incidence, triglyceride, and waist measurements. Hypertension data had three ordinal categories: normal blood pressure, borderline high blood pressure, and high blood pressure. Similarly, diabetic status had three categories: normal, prediabetic, and diabetic. All other variables were continuous and used without any dichotomization.

Statistical analysis

Figure 1 shows the step-by-step process of statistical analysis. Here, $p < 0.25$ was selected as the significance level by Mickey and Greenland's work on logistic regression and used to identify variables of importance.[24,25]

Modeling of computational biometry

In this study, the multilayer perceptron model with ordinal regression was constructed using an advanced computational statistical modeling methodology. The advanced method is a hybrid model that employs approaches, such as bootstrapping, multilayer feedforward neural networks (MLFFNs), and ordinal regression. In this methodology, the data were randomly divided into two groups: the testing and training datasets. The developed methodology relied on the testing and training datasets, predicted mean squared error (MSE), and the accuracy value of the mean absolute deviance (MAD). In phase 1, the training data were used for modeling purposes and the multilayer neural networks were fitted. In phase 2, the testing data were used for validation and ordinal regression models were utilized to investigate the underlying association between hypertension and the selected explanatory variables.

MLFFNN

MLFFNN is the most extensively used artificial neural network technology for pattern recognition, classification,

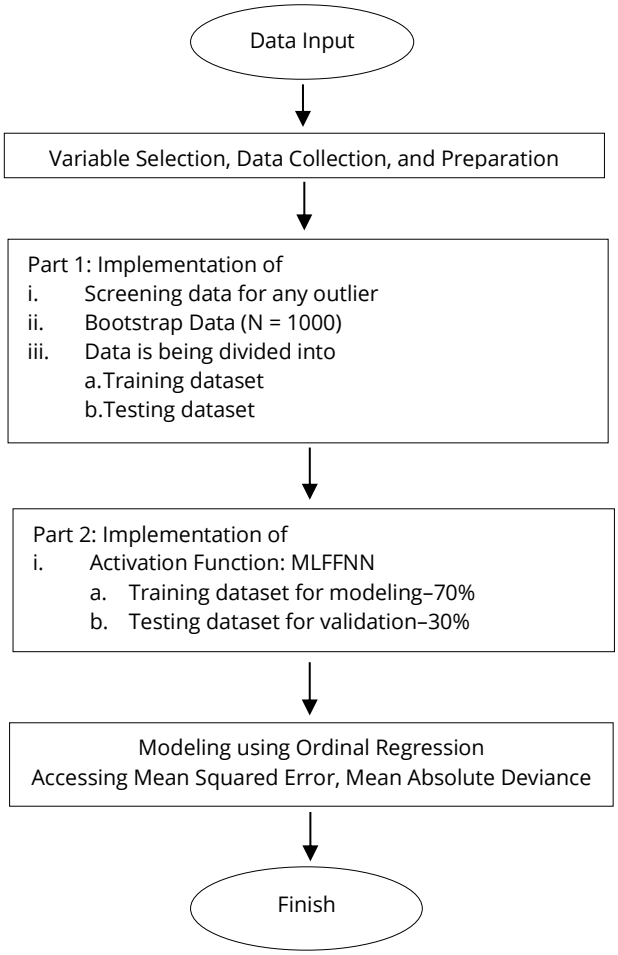

FIGURE 1. Flowchart of the proposed statistical approach

and prediction. It is a type of feedforward artificial neural network containing one or more layers between the input, hidden, and output layers. Given that the MLFFNN model contains only one dependent variable, the analysis of the output node is fixed at 1. The variable chosen from the MLFNN procedure was used as input for ordinal logistic regression (OLR).[26]

Ordinal Logistic Regression

Ordinal regression becomes useful when addressing a categorical dependent variable with more than two categories. OLR is a specific type of logistic regression that is applied when a response variable has more than two categories with a natural rank or order. For analysis, hypertension readings, which are measured on a ratio scale, were transformed into a three-category ordinal variable to capture graded risk levels and align with clinical practice.[27] The maximum likelihood method was employed to estimate regression parameter values. The ordinal model is given by $y_i^* = x_i\beta + \varepsilon_i$. However, given that the dependent variable is categorical, the following must be used:

$$C_x(x) = \ln\left[\frac{P(Y \le j \mid x)}{P(Y > j \mid x)}\right] \text{ and } \ln\left(\frac{\sum pr(event)}{1-\sum pr(event)}\right) =$$

$$\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + ,\ldots, + \beta_k X_k .$$

This can be summarized as

$$\ln\left(\frac{P(Y \le j \mid x)}{1-P(Y \le j \mid x)}\right) = \alpha_j + \beta_i X_k$$

$$i = 1...k, \quad j = 1, 2, ..., p-1,$$

where α_j = called threshold or intercept, β_i = parameter in the model, and X_{i1} = set of factors or independent variables. The equation

$$\ln\left(\frac{P(Y \le j \mid x)}{1-P(Y \le j \mid x)}\right) = \alpha_j + \beta_i X_k$$

is an ordinal logistic model for k predictors with $p - 1$ levels as the response variable.[28]

Bootstrapping

Bootstrapping involves selecting a random sample from a population and then calculating sample statistics. Through the multiple substitution of samples, a pseudo-population is created by repeatedly copying original samples. This process generates samples that differ from the original samples. Statistics were computed for each sample drawn with replacement during bootstrapping.[29]

R syntax

Statistical analysis was performed with R-Studio software package (4.2.1, R Core Development Team) by using the neuralnet package. This study examined a model that incorporated clinically relevant factors, which is one of its strengths.

```
# Dataset for the Biometry Modeling Study
Input = ("
choltot diabetes diabbp height hyper incchd trig waist
209 2 81 178.0 2 0 168 119.0
175 1 81 181.0 1 1 332 114.0
228 3 79 183.0 2 0 304 104.0
194 1 69 178.5 0 0 81 91.5
156 1 65 175.5 0 0 98 97.0
239 1 72 183.0 2 0 471 106.0
222 1 94 181.9 2 0 145 92.5
⋮ ⋮ ⋮
169 3 64 177.5 0 0 70 80.5
203 1 77 161.0 1 0 82 78.2
219 1 66 166.6 0 0 102 116.8
")
data1 = read.table(textConnection(Input),header = TRUE)
# Part 1: Multilayer Perceptron Model
# Step 1: Perform 1000 Bootstraps
mydata <- rbind.data.frame(data1, stringsAsFactors = FALSE)
iboot <- sample(1:nrow(mydata),size = 100, replace = TRUE)
data <- mydata[iboot,]
# Install the Neuralnet Package
library("neuralnet")
# Step 2: Check for Missing Values
```

```
apply(data, 2, function(x) sum(is.na(x)))
# Step 3: Max–Min Data Normalization
normalize <- function(x) [return ((x − min(x))/(max(x) − min(x)))]
maxmindf <- as.data.frame(lapply(data, normalize))
# Step 4: Determine the Training and Testing Datasets: 70% for Training and 30% For Testing
index = sample(1:nrow(data),round(0.60*nrow(data)))
Training <- as.data.frame(data[index,])
Testing <- as.data.frame(data[−index,])
# Step 5: Plot the Architecture of the MLP Neural Network
nn <- neuralnet(hyper~choltot + diabetes + diabbp + height + incchd + trig + waist,data = Training,
        hidden = c(6),act.fct = "logistic,"
        linear.output = FALSE, stepmax = 1000000)
plot(nn)
options(warn = −1)
nn$result.matrix
# Step 6: Test the Accuracy of the Model-Predicted Results—Comparison of the Predicted and Actual Results
Temp_test <- subset(Testing, select = c("choltot,""diabetes,""diabbp,""height"
        ,"incchd,""trig,""waist"))
head(Temp_test)
nn.results <- compute(nn, Temp_test)
# Step 7: Results
results <- data.frame(actual = Testing$hyper,
        prediction = nn.results$net.result)
results
# Step 8: Use the Predicted Mean Squared Error NN (MSE-Forecasts the Network) as a Measure of the Distance of Predictions from Real Data
predicted <- compute(nn,Testing[,1:8])
MSE.net <- sum((Testing$hyper - predicted$net.result)^2)/nrow(Testing)
# Step 9: Print the Predicted Mean Square Error
MSE.net
# Step 10: Neural Network Parameter Output
nn <- neuralnet(hyper~choltot + diabetes + diabbp + height + incchd + trig + waist,data = Training,
        hidden = 6,act.fct = "logistic," linear.output = FALSE,
        stepmax = 1000000)
nn$result.matrix
# Step 11: Model Validation
results <- data.frame(actual = Testing$hyper,prediction = nn.results$net.result)
results
summary(results)
# Step 12: Model Accuracy
predicted1 = results$prediction*abs(diff(range(data$hyper))) + min(data$hyper)
# Step 13: Print(Predicted)
actual1 = results$actual*abs(diff(range(data$hyper))) + min(data$hyper)
# Step 14: Print(Actual1)
deviation = ((actual1-predicted1))
Print(deviation)
# Step 15: MAD
value = abs(mean(deviation))
print(value)
accuracy_in_percent = (1-value)*100
accuracy_in_percent
# Part 2: Model the Ordinal Model
# Step 1: Build the OLR Model
library("MASS")
polr(formula = as.factor(hyper) ~ choltot + diabetes + diabbp +
        height + incchd + trig + waist, data = data, Hess = TRUE,
        method = c("logistic"))
m<-polr(formula = as.factor(hyper) ~ choltot + diabetes + diabbp +
        height + incchd + trig + waist, data = data, Hess = TRUE,
        method = c("logistic"))
# Step 2: Store the Table
(ctable <- coef(summary(m)))
# Step 3: Calculate and Store p Values
p <- pnorm(abs(ctable[, "t value"]), lower.tail = FALSE)*2
# Step 4: Combine Tables
(ctable <- cbind(ctable, `p value` = p))
# Step 5: Odds Ratios
exp(coef(m))
```

RESULTS

This study aims to investigate the performance of a MLFFNN, which is based on the activation function: ordered logistics model. This MLFFNN considered training and testing datasets. The optimal model for ordered logistic regression was identified by the MLFFNN algorithm by choosing variables that were clinically important and able to generate the lowest predicted MSE.

Results of MLFFNN modeling

Table 1 shows the results of ordered logistic regression using a training dataset wherein hypertension status is a dependent variable. The MAD of 0.00724 for the ordered logistic model indicates the distribution of the available data. A small value indicates the effectiveness of the obtained analysis in demonstrating the similarity between the predicted and actual data. Our study followed the industry standard train-to-test split of 70:30, meaning that 70% of the data are available for modeling and 30% for testing.[30] Given this situation, it is appropriate to show the accuracy and dependability of our predicted data. Figure 2 shows the network architecture of the best MLFFNN model with seven input variables, one hidden layer, and one output node.

As discussed in this section, the established bootstrap method for integrated ordered logistic regression was employed to validate variables. In this case, seven variables were chosen for analysis as follows: total cholesterol (β_1: −0.00664; $p < 0.25$), diabetes status (β_2: 0.62332; $p < 0.25$), diastolic reading (β_3: 0.08160; $p < 0.25$), height measurement (β_4: −0.05411; $p < 0.25$), CHD incidence (β_5:

1.42544; $p < 0.25$), triglyceride reading (β_6: 0.00616; $p < 0.25$), and waist reading (β_7: −0.00158; $p < 0.25$). Table 1 summarizes the results of multiple regression analysis, which found that all seven factors had a significant effect on hypertension.

Evaluation of the model

The forecast value was used for model evaluation. Prediction accuracy was determined by comparing actual and predicted values. The testing dataset was employed to evaluate the model constructed from the training dataset. The difference between the actual and predicted data was measured by using the distance prediction method. R syntax provides a model evaluation approach for the subsequent assessment. Table 2 displays the actual and predicted values obtained using the proposed methodology.

As shown in Table 3, the mean squared value for the actual data was 1.27 (SD = 0.905) and that for the predicted data was 0.98 (SD = 0.158). A paired t-test was conducted to examine the difference between these means, resulting in $p > 0.05$. This result indicated that the actual and predicted values did not significantly differ.

TABLE 1. Results of ordered logistic regression integrating bootstrapping method for training and testing datasets

Variable	Estimate	Std. Error	Z-Value	*p*
Total Cholesterol	−0.00664	0.007286	−0.91145	0.362055 e−01*
Diabetes Status	0.62332	0.315388	1.97636	0.048114 e−02*
Diastolic Reading	0.08160	0.023740	3.43725	0.000588 e−04*
Height Measurement	−0.05411	0.016238	−3.33211	0.000862 e−04*
Incidence of CHD	1.42544	0.664793	2.14418	0.032018 e−02*
Triglycerides Reading	0.00616	0.003458	1.78036	0.075016 e−02*
Waist Reading	−0.00158	0.022606	−0.06968	0.944442 e−01*
Cut 2	−3.41740	0.003816	−895.554	0.000000 e−00*
Cut 1	−2.53853	0.199198	−12.744	0.000000 e−37*

*Significant at the level of 0.25

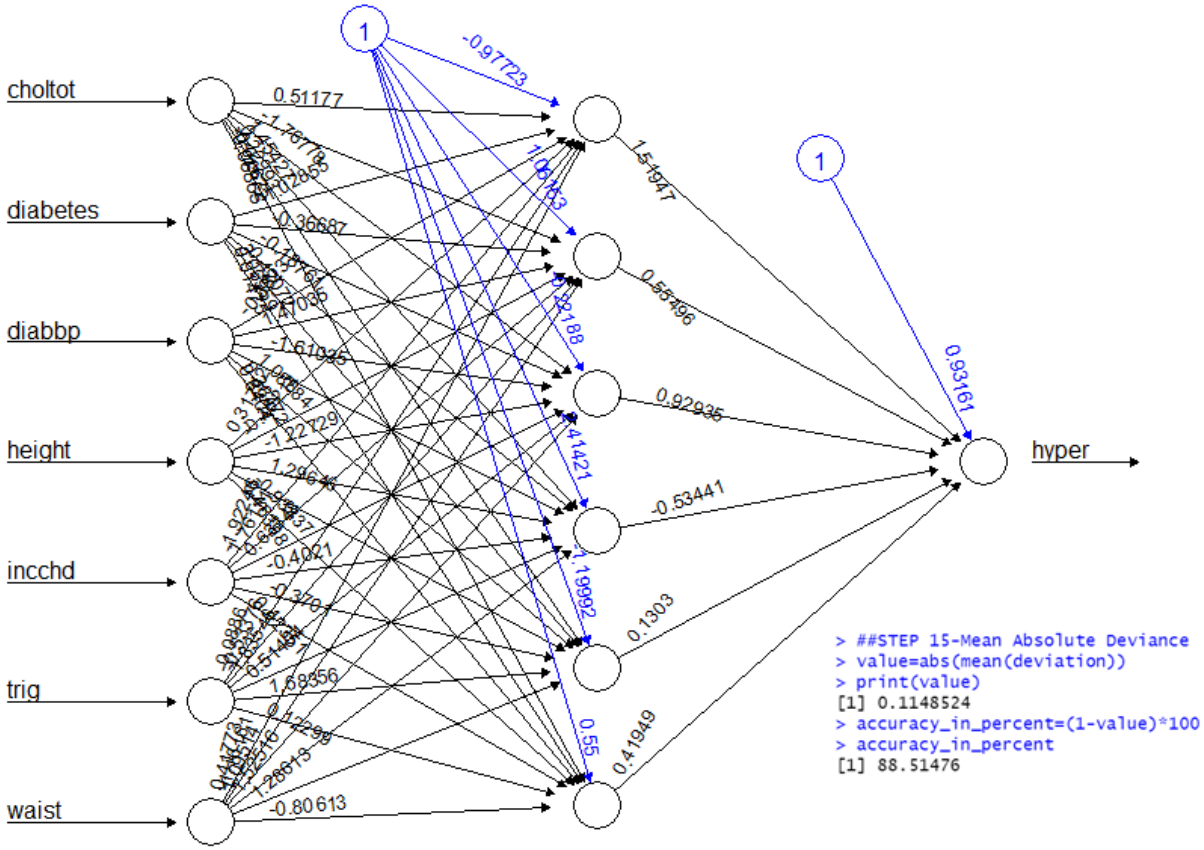

FIGURE 2. Architecture of the best MLFFNN model with seven input variables, one hidden layer, and one output node

TABLE 2. Actual and predicted values from the proposed methodology

Actual	Predicted
0	0.82964129
2	0.99952417
2	0.99952417
1	0.82964129
0	0.85360592

TABLE 3. Summary statistics of the proposed methodology

Variables	Mean ± SD	*p*
Actual	1.27 ± 0.905	0.051
Predicted	0.98 ± 0.158	

Paired samples t-test was applied

DISCUSSION

This study used a harmonized hybrid methodology to examine a model that incorporated clinically relevant factors with a direct association with hypertension. The successfully implemented method is highly accurate and valuable for estimating event probabilities (predicting the odds of being a case). However, regression modeling has several limitations, including estimation. The calculation procedures for each predictor variable and outcome are complex with low accuracy and precision. The proposed method, which is based on a single syntax calculation, improves the accuracy and precision of ordered regression modeling. The findings revealed that total cholesterol, diabetes status, diastolic reading, height measurement, CHD incidence, triglyceride reading, and waist circumference are the most critical factors influencing hypertension.

Over the past decade, numerous studies have explored the risk factors associated with hypertension. A clinical application with increased robustness for identifying risk factors can be obtained by combining MLFFNN with ordered regression analysis. For example, Chang *et al*. employed a different mining tool and found significant results indicating that triglycerides, creatinine, age, and uric acid are linked to hypertension risk.[31] Akdag *et al*. utilized decision trees and identified BMI, waist:hip ratio, gender, and triglycerides as risk factors for hypertension.[32] A study conducted in Qatar by AlKaabi obtained similar results through random forest and logistic regression analysis. It highlighted age, physical activity, fruit and vegetable consumption, and diabetes history as crucial predictors of hypertension.[33] Furthermore, a longitudinal study by Dimitriadis demonstrated the significant association of hypertension with risk factors such as age, gender, and blood glucose levels.[34]

The main objective of this project is to combine bootstrapping, MLFFNN, and ordered logistic regression techniques to develop and implement medical statistic strategies. Variable selection involves incorporating clinical expert opinion. A "mega" file is created from the initial dataset to begin the bootstrap method. The bootstrap method iteratively repeats this procedure frequently thousands of times. The R syntax algorithm aids the integration of the application with the methodology and establishes a link between the application and the notion of the method-based methodology. Training and testing use different sets of data. In this work, 30% of the bootstrap data were categorized as a testing dataset, and 70% were categorized as a training dataset. Data from the training dataset were used to build and test the model. The successful model had the smallest MAD based on actual and predicted values.

The study findings will assist decision-makers in achieving the best possible outcome. The most challenging tasks involve selecting the appropriate input parameters, preparing the data for ordered logistic modeling, and standardizing the data. The performance of the developed model is promising, and its results can be utilized as an early warning tool by health professionals to alert patients to the possibility of being hypertensive. The insights obtained from designing, developing, implementing, testing, and analyzing the network model will be valuable for future endeavors to create an early warning tool for hypertension prediction. This tool could serve as an affordable, straightforward, and rapid screening method to help the public identify their risk of hypertension.

CONCLUSIONS

This study created a hybrid approach that included bootstrapping, multilayer neural networks, ordered logistic regression, and R syntax. It demonstrated that the abovementioned methodology outperformed in terms of the R-squared values for the predicted MSE. The hybrid technique is superior to other standalone techniques and allows an improved understanding of the influence of variables on outcomes. The statistical strategy showed that regression modeling outperformed other modeling techniques and had a mean absolute deviant error of 0.00297. The model revealed that the independent variables associated with hypertension were total cholesterol, diabetes status, diastolic reading, height, CHD incidence, triglyceride reading, and waist circumference.

CONFLICT OF INTEREST

The authors declare no conflict of interest in this research.

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Relationship Between Plasma Fluoride Levels, Glutathione Peroxidase Activity, Hemoglobin, and Abortion in Rural and Urban Pregnant Women from Settat (Morocco)

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Relationship Between Plasma Fluoride Levels, Glutathione Peroxidase Activity, Hemoglobin, and Abortion in Rural and Urban Pregnant Women from Settat (Morocco)

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Abstract

Background: This study aimed to investigate the relationship between plasma fluoride levels, glutathione peroxidase activity, hemoglobin, and abortion among rural and urban pregnant women from Settat province (Morocco).

Methods: Blood samples were collected from rural pregnant women who had not undergone abortion (N = 224), rural pregnant women who had an abortion (N = 38), urban pregnant women who had not undergone abortion (N = 163), and urban pregnant women who had an abortion (N = 14).

Results: The highest ($p < 0.01$) plasma fluoride levels and the lowest ($p < 0.01$) GPx activity were observed in rural pregnant women. In all participants, plasma fluoride levels were significantly higher ($p < 0.001$), and the GPx activity was significantly ($p < 0.001$) lower in pregnant women who had an abortion compared with those who did not undergo such process. No significant difference was observed between the hemoglobin levels of all participants. Furthermore, abortion was positively correlated with plasma fluoride levels ($p < 0.001$) and negatively correlated with GPx activity ($p < 0.001$) in rural participants.

Conclusions: Rural pregnant women had higher plasma fluoride levels and lower GPx activity, which correlated with the increased abortion risk and oxidative stress.

Keywords: abortion, glutathione peroxidase, hemoglobin, plasma fluoride, pregnancy, women

INTRODUCTION

Fluoride belongs to the halogen family. This element is widely distributed in the environment, mainly in soil, air, and water.[1] At recommended doses, fluoride plays an essential role in increasing the structural stability of teeth and bones. It is also involved in human and animal growth.[2] However, chronic exposure to high fluoride levels can lead to chronic intoxications, such as dental and skeletal fluorosis.[3] Furthermore, prolonged exposure to this halogen can induce other toxic effects in the reproductive, nervous, and immune systems, which lead to nonskeletal fluorosis.[4] Fluorosis is an important public health concern in many parts of the world.[5] Moreover, fluoride intake through groundwater is a major contributor to this problem and has become one of the most critical issues affecting human health.[6] Normally, drinking water is considered contaminated when its fluoride level is between 1.1 and 2.5 ppm and toxic at fluoride levels greater than 2.5 ppm.[4] High fluoride levels in well water have been reported in several Moroccan endemic fluorosis areas.[7,8] For instance, in a study on the Bni Meskine community in the province of Settat, Morocco, the fluoride concentration was higher than the permissible limit for drinking water standards.[9]

Previous studies have emphasized that after its absorption, fluoride can bind divalent elements, such as selenium.[10] The latter is essential for the activity of glutathione peroxidase (GPx), an enzyme involved in stress response and antioxidant maintenance.[11] This bond between fluoride and selenium suggests that fluoride excess can indirectly inhibit GPx activity by binding to selenium, which results in the accumulation of reactive oxygen species (ROS) and oxidative stress.[12] Oxidative stress has been increasingly reported to cause several pregnancy complications, such as abortion and preeclampsia.[13] Oxidative stress can also result in the destruction of red blood cells through hemolysis.[14] Recently, epidemiological studies in some endemic fluorosis areas have shown the relationship between fluoride levels and pregnancy complications among women.[15–17] However, these research encountered methodological limitations, given that they only focused

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on the correlation between plasma or urinary fluoride and pregnancy complications. Therefore, other biomarkers must be investigated to understand further the possible mechanisms by which fluoride can lead to pregnancy complications. Fluorosis is endemic in Settat province,[18,19] which is composed of rural areas, where water is mainly wells, and urban areas, where water is tap water, which is filtered and controlled. This condition suggests the higher exposure of rural populations to fluoride excess. Based on the data mentioned above, the current study aimed to investigate the relationship between plasma fluoride levels, glutathione peroxidase activity, hemoglobin, and abortion in rural and urban pregnant women from Settat province (Morocco).

METHODS

This research was conducted per the principles of the Helsinki Declaration of the World Medical Association in 1964 and the Moroccan Ministry of Health recommendations relating to interventional biomedical research. To ensure ethical compliance, we submitted a formal request for approval through established hierarchical channels. To do so, we sought endorsement from the Hassan II Hospital management in Settat, the Provincial Health Delegation in Settat, the Regional Health Management of the Casablanca Settat region, and the Ministry of Health of Morocco, specifically the Directorate of Epidemiology and Disease Control. We successfully obtained Ethical Approval No. 1295/18 from the Ministry of Health of Morocco after the validation of our study.

This study was conducted on pregnant women from Settat province, Morocco, who visited the provincial public hospital Hassan II for an assessment of their pregnancy or consultation regarding an abortion. The study was conducted between June and December 2019. A total of 439 participants, aged 20–35 years old and residents of Settat province, were included in this research. All ethical principles, including free choice, informed consent, respect for confidentiality, and anonymity, were considered throughout the research. Of the 262 pregnant women from rural areas, 38 reported having undergone an abortion. Meanwhile, among 177 pregnant women from urban areas, 14 had an abortion. All participants aged less than 20 years, over 35 years, who required an emergency intervention, or who had other high-risk pregnancies were excluded. A convenience sampling technique was employed in this study. Pregnant women who visited the provincial public hospital Hassan II during the specified period were invited to participate based on their availability and willingness to participate.

Samples were collected from venous blood using heparin and ethylenediaminetetraacetic acid tubes to measure plasma fluoride levels and GPx activity, respectively. The samples were centrifuged at 3000 g for 15 min to separate the plasma and erythrocytes.

One volume of total ionic strength adjustment buffer was added to the same volumes of samples. Plasma fluoride levels, which were expressed as mg/l, were measured using a fluoride electrode (Thermo Scientific Orion 96-09, Orion Research, Cambridge, MA, USA) coupled to an analyzer ion (Star A214, Thermo Scientific Orion). The electrode was calibrated with standard fluoride solutions at concentrations of 0.025, 0.050, 0.075, and 0.1 mg/l and prepared with the same reagent used for the samples.

The GPx activity was measured following the method of Flohé and Günzler.[20] Briefly, the sample (60 µl) was incubated for 15 min at 37 °C in a reaction mixture containing 60 µl potassium phosphate buffer (0.1 M, pH 7.0), 40 µl reduced glutathione (GSH; 2 mM), 20 µl hydrogen peroxide (H_2O_2; 1 mM), and 20 µl sodium azide (1 mM). Then, 100 µl trichloroacetic acid (5%) was added to stop the reaction. After centrifugation for 5 min at 1500 g, 20 µl supernatant was collected and added to 40 µl phosphate buffer (50 mM, pH 7.0) and 140 µl 5,5-dithiobis (2-nitrobenzoic acid (0.4 mg/ml). The absorbance was read at 420 nm using a microplate reader (2100-C, Optic Ivymen Systems™, COMECTA®). The GPx activity was expressed as micromoles of GSH per minute per milligram of protein (U/mg of proteins).

The protein content in erythrocytes was estimated in accordance with the procedure described by Lowry *et al*.[21], with bovine serum albumin used as a standard. Meanwhile, hemoglobin levels were determined using an automatic hematology analyzer H 360 and expressed as g/dl.

Statistical analyses were performed using the JMP11.0 software (SAS Institute Inc., Cory, NC, USA). The Kolmogorov–Smirnov test was used to evaluate whether the data were normally distributed. The non-normally distributed numeric data were compared using the Mann–Whitney U test.[22] The correlation between abortion, plasma fluoride, GPx, and hemoglobin in rural and urban pregnant women was analyzed using Spearman's Rho test.[23]

RESULTS

Table 1 summarizes the plasma fluoride levels, GPx activity, and hemoglobin levels in rural and urban pregnant women. The results revealed that the average plasma fluoride levels were significantly higher ($p < 0.01$) in rural pregnant women (0.037 ± 0.008) than in urban pregnant women (0.035 ± 0.007). Moreover, the average GPx activity was significantly lower ($p < 0.01$) in rural pregnant women (68.10 ± 7.87 U/mg proteins) than in urban pregnant women (70.88 ± 7.78 U/mg proteins). No significant difference was observed in the hemoglobin levels.

The results in Table 2 show that the average plasma fluoride levels were significantly higher ($p < 0.001$) in

pregnant women who had an abortion (rural: 0.043 ± 0.009 mg/l; urban: 0.038 ± 0.006 mg/l) compared with those who had not (rural: 0.036 ± 0.007 mg/l; urban: 0.034 ± 0.007 mg/l). In addition, the average plasma fluoride levels were significantly higher ($p < 0.001$) in rural pregnant women who had and had not undergone abortion compared with their urban pregnant counterparts (Table 2).

The results in Table 2 also indicate that the average GPx activity was significantly lower ($p < 0.001$) in pregnant women who had an abortion (rural: 57.07 ± 1.02 U/mg proteins; urban: 57.85 ± 0.93 U/mg proteins) compared with those who had not undergone such process (rural: 69.97 ± 6.93 U/mg proteins; urban: 72.01 ± 7.06 U/mg proteins). Furthermore, the average GPx activity was significantly lower ($p < 0.001$) in rural pregnant women who had and who did not have an abortion compared with their urban counterparts (Table 2). As shown in Table 2, no significant difference was observed in hemoglobin levels between all participants.

The results of the Rho Spearman test (Table 3) revealed that in rural pregnant women, abortion was positively correlated with plasma fluoride levels (r = 0.2564; $p < 0.001$) and negatively correlated with the GPx activity (r = −0.520; $p < 0.001$). Furthermore, a negative correlation was observed between plasma fluoride levels and GPx activity (r = −0.2757; $p < 0.001$). For the urban pregnant women, the results indicated that abortion was negatively correlated with the GPx activity (r = −0.4917; $p < 0.001$). Moreover, a negative correlation was observed between fluoride and GPx activity (r = −0.1859; $p < 0.01$).

TABLE 1. Plasma fluoride, GPx activities, and hemoglobin levels in rural and urban pregnant women

Origin	Rural	Urban	*p*
Plasma fluoride (mg/l)	0.037 ± 0.008	0.035 ± 0.007	0.004
GPx (U/mg of proteins)	68.10 ± 7.870	70.88 ± 7.780	0.001
Hemoglobin (g/dl)	11.19 ± 1.250	11.17 ± 1.280	0.772

The results are expressed as average ± standard deviation

TABLE 2. Fluoride levels, GPx activities, and hemoglobin levels in rural and urban pregnant women who had or did not have an abortion

Origin	Rural	Urban	*p*
Plasma fluoride (mg/l)			
Without abortion	0.036 ± 0.007	0.034 ± 0.007	0.028
With abortion	0.043 ± 0.009	0.038 ± 0.006	0.086
p	0.001	0.007	
GPx (U/mg of proteins)			
Without abortion	69.97 ± 6.93	72.01 ± 7.06	0.003
With abortion	57.07 ± 1.02	57.85 ± 0.93	0.004
p	0.001	0.001	
Hemoglobin (g/dl)			
Without abortion	11.22 ± 1.25	11.18 ± 1.29	0.775
With abortion	11.03 ± 1.26	11.02 ± 1.16	0.620
p	0.215	0.339	

The results are expressed as average ± standard deviation

TABLE 3. Correlation between abortion, fluoride levels, GPx activity, and hemoglobin levels in rural and urban women

Residential area	Abortion	Fluoride	GPx	Hemoglobin
Rural				
Abortion	1.0000**	0.2564**	−0.5780**	−0.0520
Fluoride	0.2564**	1.0000**	−0.2757**	−0.1068
GPx	−0.5780**	−0.2757**	1.0000**	0.0516
Hemoglobin	−0.0520	−0.1068	0.0516	1.0000**
Urban				
Abortion	1.0000**	0.1372	−0.4917**	−0.0350
Fluoride	0.1372	1.0000**	−0.1859*	−0.0094
GPx	−0.4917**	−0.1859*	1.0000**	0.0146
Hemoglobin	−0.0350	−0.0094	0.0146	1.0000**

**Correlation is significant at the 0.001 level; * Correlation is significant at the 0.01 level

DISCUSSION

In Moroccan endemic areas, such as El Brouj, Beni Meskin, and Ben Hmed, which are of the Settat province, fluoride is naturally present in phosphate rocks; hence, weathering in these locations releases a high amount of fluoride that contaminates the groundwater.[4] Moreover, a study in this province revealed a high fluoride concentration in groundwater,[9] whose daily consumption can lead to diverse harmful effects. Given that blood is the main transporter of fluoride in the body,[24] plasma fluoride level is an essential parameter to diagnose the chronic toxic effects of fluoride, mainly in pregnant women.[15] The results of the current study revealed significantly higher average plasma fluoride levels in rural pregnant women than those in urban areas. The drinking water sources in each area can explain this finding. Specifically, the rural population consumes well water contaminated by excess fluoride in phosphate rocks, whereas the urban population uses tap water, which is filtered and controlled. Similarly, a study conducted in India revealed a positive correlation between plasma fluoride in pregnant women and fluoride in groundwater.[16]

Comparison of the values obtained in this previous study revealed blood fluoride levels lower than those obtained in pregnant Polish women[17] and higher than those recorded by other research.[15,25] Fluoride is transported across the placenta during pregnancy[6,26]; exposure to a high fluoride level during this critical physiological stage can cause abortion,[27] congenital abnormalities, intrauterine fetal death, anemia, neurotoxicity of the fetal brain, low birth weight, preterm delivery, and poor Appearance, Pulse, Grimace response, Activity, and Respiration (APGAR) score.[6,28–30] Therefore, the relationship between plasma fluoride levels and abortion in pregnant women was investigated in the present research. The results showed that in rural and urban areas, the plasma fluoride levels were significantly higher in pregnant women who had an abortion than those who did undergo the process, which agrees with the aforementioned studies' findings. On the other hand, previous studies reported that some factors, such as malnutrition,[31] infections,[32] and environmental pollutants,[33] can cause oxidative stress, which leads to the progression of several pregnancy complications, such as abortion, preterm birth, miscarriages, gestational diabetes, and fetal growth restriction.[34–36] However, to our knowledge, none of such studies have documented the associations regarding fluoride, antioxidant status, and adverse pregnancy outcomes. Therefore, in the present work, the relationship between plasma fluoride levels, GPx activity, and abortion was investigated. Our findings revealed that erythrocyte GPx activity was significantly lower in pregnant women who had an abortion than those who had not. Hence, from these results, fluoride can increase the risk of abortion in pregnant women via oxidative stress pathways.

As highlighted previously, fluoride is an electronegative element, and after its absorption, it binds to several divalent elements, such as calcium, magnesium, zinc, and selenium.[11] Selenium is a necessary cofactor for the activity of the selenoenzyme GPx, which is involved in the stress response and maintenance of high levels of antioxidants in the body.[12] Hence, excess fluoride can inhibit the GPx activity by binding to selenium, which leads to ROS accumulation and oxidative stress. Superoxide dismutase and GPx are the main antioxidant enzymes;[37] the first catalyzes the dismutation of superoxide anion free radical (O_2^-) into molecular oxygen and hydrogen H_2O_2,[38] and the second catalyzes the transformation of H_2O_2 into H_2O. In this study, the negative correlation between plasma fluoride levels and the GPx activity was possibly due to the inhibition of GPx by fluoride, which can pave the way for Fenton's reaction, which decomposes hydrogen peroxide catalytically to generate hydroxide (OH^-) and hydroxyl radicals ($HO^•$). Furthermore, these powerful oxidizing agents cause oxidative stress,[39] which can result in aberrant spiral artery formation, increased placental vascular resistance, and decreased uterine perfusion. In addition, ROS can damage DNA, lipids, and proteins, shorten telomeres, accelerate the aging of fetal membranes, and induce the aging of placental structures, which leads to their failure and the development of pregnancy complications such as abortion.[40] ROS can also damage endothelial cells, resulting in an altered prostacyclin–thromboxane balance that leads to preeclampsia or abortion.[13]

This study is the first of its kind in Morocco, and it focuses on abortion and its relationship with fluoride exposure. However, this research encountered several limitations. Most importantly, obtaining a sufficiently large sample size of pregnant women meeting the specified characteristics was challenging. Moreover, some participants did not provide the necessary information to determine whether their abortion was related to fluoride exposure or other causes.

CONCLUSIONS

In conclusion, rural pregnant women had higher plasma fluoride levels and lower GPx activity than those in urban areas. Abortion was positively correlated with plasma fluoride levels and negatively correlated with the GPx activity in rural pregnant women. These findings suggest a potential link between excessive fluoride exposure and increased abortion risk, possibly mediated by oxidative stress. Extensive biochemical and molecular studies are needed to further gain insights into the underlying mechanisms behind abortion in areas with endemic fluorosis. Future research will focus on the specific biochemical and molecular pathways involved in the association between fluoride excess and abortion to

develop targeted prevention measures to mitigate the associated risk.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Association between rs2787094 Genetic Variants in ADAM33 Gene and Asthma in Indonesian Population: Preliminary Study

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Abstract

Background: Asthma is a multifactorial disease that encompasses a multitude of genetic and environmental factors. One such factor is the disintegrin and metalloprotein-33 (ADAM33) gene, which is correlated with asthma and bronchial hyperresponsiveness. Previous studies conducted on Asian populations have reported a significant association between rs2787094 polymorphism in the ADAM33 gene and asthma.

Methods: Our study involved 153 Indonesian participants. TaqMan genotyping assay was used to analyze rs2787094 polymorphism in the ADAM33 gene.

Results: No significant association was detected between the allele and genotype frequencies of rs2787094 and asthma in the case and control subjects (p = 1.00). The distribution of rs2787094 genotypes in healthy controls was CC (12.1%), CG (42.1%), and GG (45.8%). The genotype distribution in Indonesians was similar to East Asians in 1,000 genomes dataset.

Conclusions: This is the first study to investigate the association between rs2787094 polymorphism in the ADAM33 gene and asthma in the Indonesian population and concluded that it is not associated. Future studies with larger sample sizes and more single nucleotide polymorphisms in the ADAM33 gene are needed to validate these results.

Keywords: ADAM33 gene, asthma, gene polymorphism, Indonesia, rs2787094

INTRODUCTION

Current estimates suggest that asthma is the most prevalent chronic respiratory condition worldwide, directly impacting approximately 358 million individuals.[1] Despite successful therapies and new management paradigms, asthma significantly affects patient's lives. Furthermore, >45% of sufferers are estimated to have a poorly managed condition.[2] Despite global efforts, the mortality rate from asthma remained constant at 0.19 deaths per 100,000 individuals from 2006 to 2012.[3] This disease is among the top 10 causes of morbidity and mortality in Indonesia.[4] Based on 2018 data from the Ministry of Health Indonesia, asthma had a prevalence of 2.4%, accompanied by a recurrence rate of 57.5%.[5]

The clinical presentation of asthma is strongly associated with airway inflammation, a defining feature of the disease, along with bronchial hyperresponsiveness (BHP) and reversible airflow obstruction.[6] The pathogenesis of asthma is multifaceted, involving genetic and environmental factors. Thus, genetic factors are a promising clinical and basic research area.[6–8] Among such genetic factors are the disintegrin and metalloprotein-33 (ADAM33) gene, linked to susceptibility to asthma and BHP.[9] This highly polymorphic gene is located on human chromosome 20p13 and encompasses over 300 single nucleotide polymorphisms (SNPs) associated with asthma and other allergic conditions.[10–13] Among these SNPs, rs2280090, rs2787094, rs511898, and rs2280089 have a significant relationship with asthma, especially in Asian populations.[14] Particularly, rs2787094 polymorphism has revealed consistent results in several studies on Asian populations.[6,11,15,16]

Few genetic data are available on the association between ADAM33 polymorphism and asthma in Indonesia. rs2787094 polymorphism is essential for the functional activity and transcriptional regulation of ADAM33 expression, such as modifying signaling activity or binding specific microRNAs.[17] rs2787094 polymorphism has been studied in asthmatic patients from different ethnic populations.[14] Therefore, this preliminary study examined the association between rs2787094 polymorphism in the

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ADAM33 gene and asthma among YARSI University students.

METHODS

Subjects

This study involved 46 individuals diagnosed with asthma and 107 healthy controls. We collected the samples in January–March 2016 at the Faculty of Medicine from students of YARSI University Jakarta, Indonesia. A clinical immunology and allergy specialist assessed participants based on clinical examinations and family history, as well as guidelines established by the global initiative for asthma,[18] and the international study of asthma and allergies in childhood.[19] We only enrolled participants with hereditary asthma and did not assess their lung capacity. Normal individuals had no symptoms of asthma, allergy, autoimmunity, or inflammatory disease. The study groups were negative for parasitic diseases. This study was approved by YARSI University Ethics Committee (No. 023/KEP-UY-BIA/III/2016), and the participants signed informed consent.

DNA extraction and SNP genotyping

About 3 mL of peripheral blood was collected from the participants into an EDTA tube. About 500 µL of blood was drawn for automated DNA isolation using Maxwell Automated DNA instrument (Promega, Madison, WI, USA). Tecan Infinite 200 Pro nano spectrophotometer (Tecan, Mannedorf, Switzerland) was used to evaluate the quality and quantity of the extracted DNA. An analysis of quality and integrity was performed by gel electrophoresis.

rs2787094 polymorphism in ADAM33 gene was genotyped using 10 ng of DNA mixed with the TaqMan GT Express (Thermo Fisher Scientific, Waltham, MA, USA). TaqMan SNP rs2787094 genotyping assay (Thermo Fisher Scientific) was conducted following the manufacturer's instructions, SNP was genotyped using the real-time polymerase chain reaction (PCR) thermal cycler LightCycler 480 (Roche, Basel, Switzerland). PCR program included the following cycling conditions: 95 °C for 10 min, 40 cycles at 92 °C for 15 s, and 60 °C for 1 min. The amplification analysis was performed utilizing allelic discrimination, and the automated allele calling settings for Light Cycler Software 4.0 (Roche, Basel, Switzerland) were employed.

Data analysis

Comparisons between the groups were evaluated by χ^{2}-test. A two-tailed p-value < 0.05 was considered significant. Odd ratios were used to estimate relative risk with 95% confidence intervals. The distribution of the alleles and genotypes was determined, and the genotype frequency data were compared to 1,000 genomes dataset (https://asia.ensembl.org/Homo_sapiens/Variation/). We used rs2787094 genotype frequency data from South Asian, European, East Asian, Ad Mixed American, and African populations and compared them with our study. All statistical analyses were conducted utilizing SPSS software version 22 (SPSS Inc., Chicago, IL, USA).

RESULTS

A total of 153 participants, comprised of 46 participants with asthma (8 men, 38 women, and 22.37 years mean age) and 107 healthy control subjects (59 men, 41 women, and 25.70 years mean age), were included in this study. Table 1 shows the allele and genotype frequencies of rs2787094 polymorphism in ADAM33 gene. The allele and genotype frequencies were relatively similar between individuals with and without asthma (healthy controls). The Hardy–Weinberg equilibrium test revealed that the control group population adhered to Hardy–Weinberg proportions (p = 0.594). We observed no significant difference between the frequencies of the cases and controls (Table 1).

Figure 1 is a genotype discrimination cluster plot. The diagram was analyzed using EndPoint Genotyping Analysis on Light Cycler Software 4.0 software. The results demonstrated that the non-template control (NTC) was distant from all clusters, and three clusters were separated. Figure 2 compares the genotype distributions between Indonesian and other populations based on 1,000 genomes dataset. The results indicated similarity to the populations studied in East Asian countries, including Han Chinese in Beijing, China, Japanese in Tokyo, Japan, Southern Han Chinese Population, Chinese Dai in Xishuanaqbanna, China, and Kinh in Ho Chi Minh City, Vietnam, according to the Ensembl information data (https://asia.ensembl.org/Homo_sapiens/Variation/). However, no significant differences were observed between Indonesian and other populations.

TABLE 1. Allele and genotype frequencies of rs2787094

SNP	Position	Allele	Asthma (N = 46)		Non-Asthma (N = 107)		*p*	OR (95% CI)
			N	%	N	%		
rs2787094	3649161	Allele						
		C	31	33.7	71	33.2	Reference	
		G	61	66.3	143	66.8	1	1.02 (0.61–1.72)
		Genotype						
		CC	5	10.9	13	12.1	Reference	
		CG	21	45.6	45	42.1	0.78	0.82 (0.26–2.61)
		GG	20	43.5	49	45.8	1	0.94 (0.30–3.00)

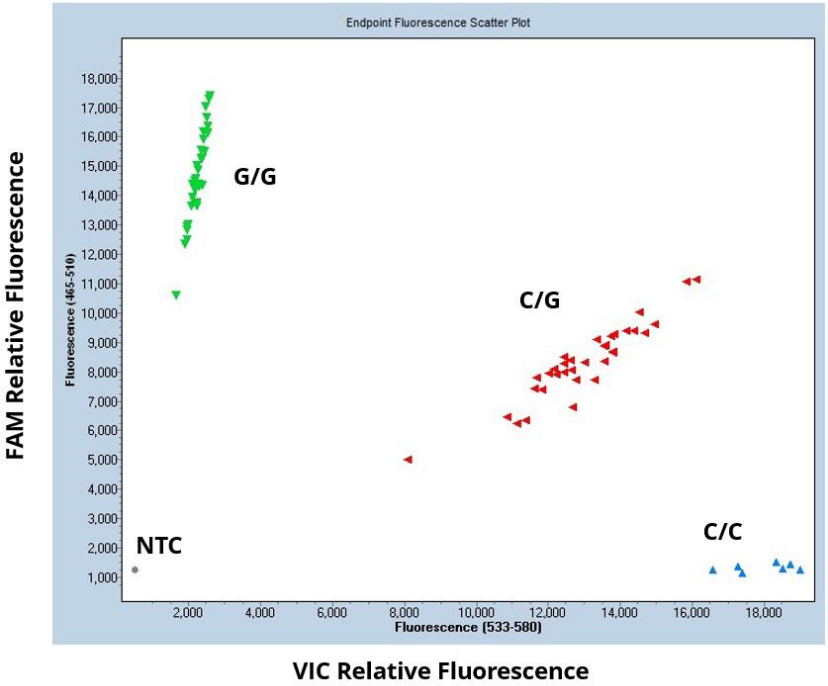

FIGURE 1. Distribution of rs2787094 polymorphism using LightCycler® 480 software; single dots represent genotyped individuals; green represents the GG genotype; red represents CG genotype; blue represents CC genotype

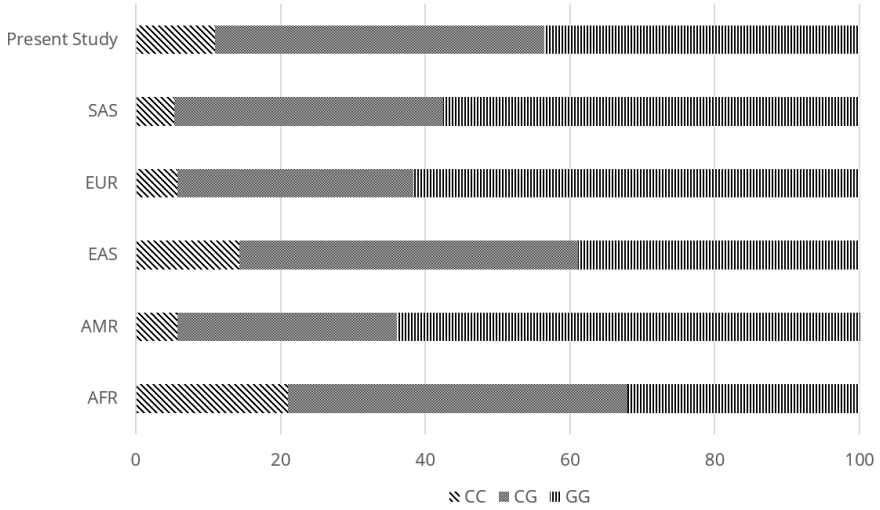

FIGURE 2. Distribution of rs2787094 polymorphism in Indonesian population compared to other populations using 1,000 genomes dataset; SAS: South Asian; EUR: European; EAS: East Asian; AMR: Ad Mixed American; AFR: African

DISCUSSION

Asthma is a multifactorial disorder arising from a complex interplay between genetic and environmental factors. Polymorphisms in ADAM33 gene have been associated with asthma in diverse populations.[11] ADAM33 is expressed specifically by mesenchymal cells, and changes in its activity alter the function of bronchial smooth muscle cells and fibroblasts, leading to airway remodeling.[9] The objective of this investigation was to examine the correlation between rs2787094 polymorphism and asthma. To our knowledge, no study has assessed the association between ADAM33 polymorphisms and asthma in an Indonesian population.

Our results indicated no association between the allele and genotype of rs2787094 in ADAM33 gene and the risk of asthma. This contradicts a previous study in the Asian population;[14,16,20] however, Karimi *et al*. reported an association between moderate asthma and G rs2787094

allele but no association was shown in mild and severe asthma.[20] Meta-analysis also showed that rs2787094 only has a positive association in the Asian population, whereas no significant association was observed in European or Latin American populations.[14]

This study used TaqMan SNP genotyping assay for rs2787094 genotyping, which is one of the most reliable methods for SNP genotyping due to cost-effectiveness and ease of handling. This assay allows genotyping of individuals for a specific SNP, making it a valuable tool for genetic association studies.[21] Our results revealed a good separation cluster; however, the cluster included a trailing cluster. This trailing cluster, which appears to spread across an imaginary line that extends from NTC, was attributed to variations in the concentration of genomic DNA in the samples.[22] Although we normalized the samples to the same concentration, we continued to get this trailing cluster, possibly because we used absorbance at 260 nm to quantify DNA concentration. To obtain a more accurate measurement of DNA concentration, a fluorescent method should be used rather than measuring absorbance at 260 nm.[23]

The distribution of rs2787094 polymorphism varies across different ethnicities globally. Our findings revealed that the genotype distribution of rs2787094 was comparable to the East Asian population studied. According to Ensemble (www.ensembl.org), EAS population study consists of Han Chinese from Beijing, China, Japanese from Tokyo, Japan, the Southern Han Chinese Population, Chinese Dai from Xishuanaqbanna, China, and Kinh from Ho Chi Minh City, Vietnam. However, no significant difference was found with the other populations in this study due to the small sample size and lack of ethnic specification.

Our study had limitations due to the small sample size. Future studies with larger sample sizes should be conducted to confirm our findings. Additionally, we recruited participants with hereditary asthma; therefore, further studies need to collect non-hereditary asthma samples, their lung capacity data, and environmental factors that cause asthma to strengthen the study. Additionally, further investigations of more ADAM33 gene SNPs to detect an association with asthma in the Indonesian population are needed. Understanding the genetics of asthma would support the development of a powerful predictive marker for preventing and managing asthma.

We also did not characterize asthma patients as mild, moderate, or severe asthma, which could potentially affect the results. Additionally, we did not specify the ethnicity of the participants. However, in future studies, it may be important to specify ethnicity, given that Indonesia has over 300 indigenous languages and associated ethnic groups.[24] Multiple genes have been identified and mapped in various ethnicities in Indonesia, including but not limited to human leukocyte antigen,[25] N-acetyltransferase 2,[26–28] and the GSTM1/GSTT1 null genotype.[29]

CONCLUSIONS

In conclusion, this study demonstrated no association between rs2787094 polymorphism and asthma in the Indonesian population. However, this may be the first study in Indonesia that investigated the role of ADAM33 polymorphism in this population. We observed a similarity in rs2787094 genotype distribution with EAS population. To obtain more reliable results, future studies with larger sample sizes are recommended, and screening of all ADAM33 gene SNPs may provide a better avenue for further research.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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