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Conclusion should elucidate how the results communicate to the theory presented as the basis of the study and provide a concise explanation of the allegation of the findings.

ACKNOWLEDGEMENT

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The Future of Regenerative Medicine: Stem Cell Research in Pakistan

OPEN ACCESS

Anna Maria Lavezzi[1]

[1]Lino Rossi Research Center-Department of Biomedical, Surgical & Dental Sciences, University of Milan, Milan, Italy
anna.lavezzi@unimi.it

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The landscape of medicine is being revolutionized by the recent breakthroughs in stem cell research that offer new possibilities for treating diseases that were once deemed degenerative, incurable, or irreversible. In low and middle-income countries like Pakistan stem cell therapy holds promise for cost-effective solutions to non-communicable diseases. However, these advancements are hindered by ongoing debates, legal challenges, and public controversies.

Stem cells can differentiate into various cell types and self-renew themselves, making them appealing for regenerative medicine. Unlike traditional therapies, regenerative medicine focuses on the restoration of optimal functioning of the damaged tissues and organs. Stem cells can be categorized as embryonic and adult stem cells. Adult stem cells such as mesenchymal stem cells can differentiate into various cell types. These can be obtained from bone marrow, adipose tissue, umbilical cord tissue, and amniotic fluid.

Research shows that stem cells have the potential to treat cancers and advance regenerative medicine. Genetically modified stem cells can act as delivering systems for the treatment of genetic disorders and the development of therapeutic agents directly targeted to organs. Successful differentiation of stem cells into neurons, cardiomyocytes, insulin-producing cell clusters, hepatocytes, and hematopoietic precursors. These achievements are powerful tools that can help in combating human diseases.

In Pakistan, while the potential of stem cell therapy has generated significant excitement, the progress is hindered by regulatory and infrastructure challenges. Addressing these concerns and fostering a supportive research environment is essential for advancing stem cell and regenerative medicine in the country. According to the WHO International Clinical Trials Registry, there are over 3000 trials on adult stem cells in progress [1]. These trials are essential in advancing the knowledge of stem cell therapies and for the establishment of realistic expectations for their outcomes. The transplantation of stem cells into non-native environments can pose risks, including tumor formation and other complications. These risks underscore the importance of rigorous evaluation and monitoring to ensure that these promising therapies are both safe and effective before they become widely available.

In conclusion, stem cell research has great potential to revolutionize healthcare in Pakistan, but ethical, regulatory, and infrastructure challenges must be overcome before its benefits can be fully realized in regenerative medicine. An environment that is supportive and safe is imperative for clinical trials and research to ensure safe and effective therapies in the future.

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Original Article

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Factors Associated with Diabetic Foot Ulceration among Diabetes Mellitus Type 2 Patients at Dow University Hospital, Karachi

Syed Muhammad Adnan[1*], Samreen Fatima[2] and Syed Muhammad Hasan[3]

[1]Department of Community Medicine, Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan
[2]Department of Statistics, University of Karachi, Karachi, Pakistan
[3]Department of National Institute of Diabetes and Endocrinology, Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan

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***Corresponding Author:**
Syed Muhammad Adnan
Department of Community Medicine, Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan
syed.adnan@duhs.edu.pk

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ABSTRACT

Diabetic foot ulcer is one of the important problems related to diabetes which affects the quality of life of the diabetic patients. **Objective:** To determine the factors (demographic characteristics, glycemic control, CVD or CKD) associated with diabetic foot ulceration among diabetic patients. **Methods:** A registered patient's data taken from Dow University Hospital (DUH), Karachi.The multiple risk factors which includedphysical activity, smoking status, dietary intakes, duration of diabetes and co-morbidities. Multiple logistic regression and STATA version 15 was used to analyze the overall results and p value < 0.05 was considered to statistically significant.**Results:** In DM Type 2 patients, 664(71.4%) were male and 266 (28.6%) were female and the median age was 53.23 years.The hypertensive patients were 4.33 times higher risk of developing DFU (OR=4.33, 95% CI: 2.11-8.89, p<0.001) and the CVD patients was 2.67 times higher risk of developing DFU (OR=2.67, 95% CI: 1.25-5.68, p=0.011). The diabetic patients who did regularly exercises were 68% less chances of risk of developing DFU (OR=1.68, 95% CI: 0.16-0.74 p=0.006). On the other hand, the diabetic patients for regular foot checkup were 2.02 times less chances of developing DFU (OR=2.04, 95% CI: 0.02-0.11 p<0.001).According to evaluation of HADS, the anxiety (p=0.023) and depression (p<0.01) score were more increased in DFU patients as compare to without DFU patients. **Conclusions:** Risk factors (age, BMI, duration of diabetes, physical activity, co- morbidities and anxiety and depression) were highly connected with DM type 2 diabetic foot ulcers patients.

INTRODUCTION

Diabetes Mellitus is a chronic lifelong metabolic disorder characterized by increase level of blood sugar and there are abnormalities in carbohydrate, protein and fat metabolism. Worldwide diabetes is one of the prime causes of death and disability and based on etiology it is divided into four categories, type I diabetes, type II diabetes, gestational diabetes and other specific type [1]. Certain macro vascular and micro vascular complications are associated to diabetes, macro vascular complication involves large blood vessels consist of cardiovascular disease, and peripheral vascular disease, on the other hand small blood vessel involve in micro vascular complication which comprise nephropathy, retinopathy and neuropathy [2]. Worldwide prevalence of adult diabetes is 537 million between the age group of 20 to 79, which is by 2030 a number of 643 million people or one adult in 10, this means in every 10 second approximately 3 new cases of diabetes will appear.Prediction of worldwide increasing of diabetes cases is about 783 million by 2045 [3]. According to international diabetic foundation in Pakistan, diabetic inhabitants were estimated 6.9 million people of age group 20 to 79 years in 2003, and it is predictable to reach 11.5 million by 2025, this produces the diabetic population of Pakistan on 1st position, in next ten years in Pakistan, deaths by diabetes alone estimated to rise by 51% [4]. It is predictable that just about 15% of the more than 150 million people with diabetes worldwide will at some stage build up diabetic foot ulceration [5]. Foot ulceration is disabling and

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common diabetic complication and life time threat to develop this complication may be as high as 25% in patient having diabetes [6].In diabetic people lower extremity disease, including, foot ulceration, peripheral neuropathy and lower extremity amputation are twofold common as compared to non-diabetic people and if the diabetic person is older than 40 years its affect 30% [7]. The risk of new diabetic foot ulceration increases if there is history of previous foot ulceration. Diabetic foot ulceration precedes 85% of lower limb amputation and after limb amputation mortality rate is high [8].In Pakistan the burden of DFU is varies from 10 to 22% and the cases of amputation in DFU patients is ranges from 8-21%, based on used of methodology and treatment of the disease [9].

DFU is an important issue and few researches conducted in this issue especiallyinourcommunity,thereforein thecurrentstudydeterminedthedifferent factors associated with DFU in order to recover their quality of life and minimize the heavy cost of treatment.

METHODS

An institional based retrospective case control study was conducted and the hospital recorded patients data were taken during the period of january 2010 to May 2017 from the permission of institutional head of National Institute of Diabetes and Endocrinology, DUH, Karachi with Reference No: DUHS/NIDE/2017-07-129. Detailed history from each patients regarding demographic profile (age, gender, marital status, income, education, occupation), physical activity, smoking status, dietary intakes, co-morbidities (HTN, dyslipidemia, CVD), foot hygiene's, Haemoglobin A1c (HBA1C), Fasting Blood Sugar (FBS), Random Blood Sugar (RBS), cholesterol levels, duration of diabetes, duration of hypertension and duration of diabetes foot ulcer were included after taken informed consent. A non-probability consecutive sampling technique was used for including the all diabetic type 2 foot and withoutfoot ulcer patients. All T2DM patients either gender andage were included in this study. At the time of history taken from patients with unilateral or bilateral amputations were excluded from the study. Data were entered in Microsoft Excel and analyzed in STATA version 15. Descriptive statistics were calculated for numerical data like age, duration of diabetes etc., and frequencies (percentages) in case of categorical data like classification of diabetic foot ulcer, co-morbidities or smoking status. Chi-square test of association was applied on data to analyses the direction of association of categories of foot ulcer with age, gender, Body Mass Index (BMI)(underweight, normal, overweigh and, obese) and co-morbidities, i.e. Hypertension (HTN), dyslipidemia, Choronic Kidney Diseases (CKD) and Cardio Vascular Diseases (CVD). Multivariate logistic regression analysis was applied among study variables with Adjusted Odds Rations (AOR) and 95% CI for determining the strength of association.Mann Whitney U test was used after applying Shapiro Wallis test of normality to compare the two independent variables. P-value < 0.05 was considered for statistical significant result.

RESULTS

A total n=930 DMType 2 patients (without foot ulcer n=465 and with footulcer n=465) were included in the study. In DM Type 2 patients, 664(71.4%) were male and 266 (28.6%) were female. The median age was 53.23, BMI, 28.44, duration of diabetes, 9.14, duration of hypertension, 3.12,HBA1c,8.08, low-density lipoproteins (LDL), 117.51, High-density lipoprotein (HDL), 29.18 and total cholesterol was 196.17(Table 1).

Table 1: Characteristics of Study Population

Variables	Median	IQR
Age	53.23	12.82
Income	35028.99	14.32
BMI	28.44	13.62
Waist to Hip Ratio (WHR)	0.92	1.02
Duration of Diabetes	9.14	3.31
Duration of Hypertension	3.12	2.13
HBA1C	8.08	3.43
Low-Density Lipoproteins (LDL)	117.51	10.99
High-Density Lipoprotein (HDL)	29.18	5.02
Total Cholesterol	196.17	5.30
Triglyceride	95.76	7.25

Patients with DFU were mean age (58.44 ± 15.12 years) higher than patients without foot ulcer mean age (49.13 ± 7.82 years, p<0.001). The average period of diabetes was rise in foot ulcer patients (9.03 ± 3.38 years) than patients having no sign of diabetic foot ulcer (3.14± 2.31 years, p<0.001). The average BMI of diabetic foot ulcer cases was higher (26.50 ± 5.39) than the without diabetic foot ulcer (24.44 ± 4.62, p= 0.039). The average HBA1c was higher in diabetic foot ulcer (9.91 ± 2.71) than the without diabetic foot ulcer(6.08 ± 1.32, p<0.001)(Table 2).

Table 2: Distribution of Descriptive and Demographics of Continuous Variables among the Classification of DFU

Variables	DFU		
	Yes (Mean ± SD)	No (Mean ± SD)	p-Value*
Age	58.44 ± 15.12	49.13 ± 7.82	<0.001
Income	14579.71 ± 4486.6	19028.99 ± 7553.67	0.034
BMI	26.50 ± 5.39	24.44 ± 4.62	0.039
WHR	0.92 ± 0.04	0.88 ± 0.05	<0.001
Duration of Diabetes	9.03 ± 3.38	3.14 ± 2.31	<0.001
Duration of Hypertension	4.78 ± 3.30	0.87 ± 1.13	<0.001
HBA1c	9.91 ± 2.71	6.08 ± 1.32	<0.001
LDL	128.83 ± 16.01	117.51 ± 13.99	<0.001
HDL	31.97.83 ± 5.09	29.18 ± 8.02	0.013
Total Cholesterol	201.87 ± 12.32	196.17 ± 3.30	0.025
Triglyceride	127.43 ± 18.62	95.76 ± 11.25	<0.001

*P-value calculated by Mann Whitney U Test

There was a statistically positive association between co-

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morbidity (HTN, Dyslipidemia and CVD) and diabetic foot ulcer. The hypertensive patients were 4.33 times higher risk of DFU as compared to non -hypertensive patients (OR=4.33, 95% CI: 2.11-8.89, p<0.001). Similarly, the CVD patients was 2.67 times higher risk of foot ulcer (OR=2.67, 95% CI: 1.25-5.68, p=0.011). The physical activity, diabetic diet and proper medications were also significantly associated with DFU. The diabetic patients who did regularly exercises were 34% less chances of risk of DU (OR=0.34, 95% CI: 0.16-0.74 p=0.006). On the other hand, the diabetic patients who visit regular for foot checkup were4%less chances of risk of diabetic foot ulcer(OR=0.04, 95%CI: 0.02-0.11 p<0.001),(Table3).

Table 3: Association between Dichotomous Variables among the Classification of Foot Ulcer

Variables	DFU			
	Yes N (%)	No N (%)	OR(95% CI)	p-Value*
Gender				
Male	50 (71.4%)	47 (67.1%)	1.22 (0.60-2.51)	0.583
Female	20 (28.6%)	23 (32.9%)		
HTN				
Yes	42 (60.0%)	18 (25.7%)	4.33 (2.11-8.89)	<0.001
No	28 (40.0%)	52 (74.3%)		
Dyslipidemia				
Yes	40 (57.1%)	27 (38.6%)	2.12 (1.08-4.17)	0.029
No	30 (42.9%)	43 (61.4%)		
CVD				
Yes	28 (40.0%)	14 (20.0%)	2.67 (1.25-5.68)	0.011
No	42 (60.0%)	56 (80.0%)		
Exercise				
Yes	42 (60.0%)	57 (81.4%)	0.34 (0.16-0.74)	0.006
No	28 (40.0%)	13 (18.6%)		
Diabetic Diet				
Yes	21 (30.0%)	52 (74.3%)	0.15 (0.07-0.31)	<0.001
No	49 (70.0%)	18 (27.7%)		
Regular Foot Checkup				
Yes	16 (22.9%)	61 (87.1%)	0.04 (0.02-0.11)	<0.001
No	54 (77.1%)	09 (12.9%)		
Regular Diabetic Medication				
Yes	23 (32.9%)	48 (68.6%)	0.22 (0.11-0.46)	<0.001
No	47 (67.1%)	22 (31.4%)		
Regular Cholesterol				
Medication				
Yes	26 (37.1%)	46 (65.7%)	0.31 (0.15-0.62)	0.001
No	44 (62.9%)	24 (34.3%)		
Cigarette Smoking				
No	14 (20.0%)	48 (68.6%)	-	<0.001
Ex-Smoker	10 (14.3%)	6 (8.6%)		
< 1 packet per day	20 (28.6%)	11 (15.7%)		
> 1 pack per day	26 (37.1%)	5 (7.1%)		

Author Computations; *p-value calculated by logisticre gression analysis

The multiple regression analysis showed that, there was a statistically significant relationship between gender, age and co-morbidity (HTN, Dyslipidemia, CVD) with diabetic foot ulcer patients. The hypertensive patients was 3.23 times higher risk of developing DFU as compared to non-hypertensive patients (OR=2.33, 95% CI: 2.11-3.89, p<0.001). Similarly, the CVD patients was 2.69 times higher risk of developed foot ulcer (OR=2.69, 95% CI: 1.25-5.68, p=0.011). The physical activity, obesity history and smokers were also significantly associated with developed diabetic foot ulcer. The diabetic patients who did regularly exercises were 68% less chances ofrisk of developing DFU (OR=1.68, 95% CI: 0.16-0.74 p=0.006). On the other hand, the diabetic patients who visit regular for foot checkup were 2.02 times were less chances of developing DFU (OR=2.04, 95% CI: 0.02-0.11 p<0.001)(Table4).

Table 4: Association between Factors of DFU with DM Type 2 Patients

Variables	Diabetic Foot Ulcer		Logistic Regression Analysis	
	Yes N (%)	No N (%)	AOR (95%CI)	p-Value
Gender				
Male	312 (67.09%)	332 (71.40%)	1.00	0.023
Female	153 (32.90%)	133 (28.60%)	1.22 (0.60-2.51)	
Age				
<30	9 (1.93%)	12 (2.58%)	1	0.019
30-39	189 (40.64%)	186 (40.00%)	1.43 (0.92-1.23)	
40-49	169 (36.34%)	158 (33.98%)	1.22 (1.2-1.98)	
50-59	67 (14.41%)	59 (12.69%)	1.49 (0.69-1.86)	
>60	33 (7.10%)	47 (10.11%)	1.23 (0.92-1.12)	
Marital Status				
Married	356 (76.56%)	292 (62.80%)	1.92 (1.23-1.89)	0.129
Unmarried	109 (23.44%)	173 (37.20%)	1	
HTN				
Yes	42 (60.0%)	112 (24.09%)	2.33 (2.11-3.89)	<0.001
No	28 (40.0%)	353 (75.91%)	1	
Dyslipidemia				
Yes	298 (64.09%)	127 (27.31%)	2.12 (1.08-2.56)	0.029
No	167 (35.91%)	338 (72.69%)	1	
CVD				
Yes	197 (42.36%)	49 (10.54%)	2.67 (1.25-5.68)	0.011
No	268 (57.64%)	416 (89.46%)	1	
CKD				
Yes	223 (47.96%)	36 (7.74%)	1.67 (1.25-3.68)	0.928
No	242 (52.04%)	429 (92.26%)	1	
Exercise				
Yes	42 (9.03%)	298 (64.09%)	1.68 (0.16-2.74)	<0.001
No	423 (90.97%)	167 (35.91%)	1	
Obesity History				
Yes	321 (69.03%)	86 (18.49%)	2.15(0.07-3.31)	<0.001
No	144 (30.97%)	379 (81.51%)	1	
Delay for Follow-Up				
Yes	389 (83.66%)	61 (13.12%)	2.04 (1.02-2.11)	<0.001
No	76 (16.34%)	404 (86.88%)	1	

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Infection History				
Yes	344 (73.98%)	51 (10.97%)	3.59 (1.02-3.11)	0.029
No	121 (26.02%)	414 (89.03%)	1	
Baseline Medication				
Insulin	166 (35.70%)	267 (57.42%)	1.22 (0.11-1.46)	0.980
Oral	299 (64.3%)	198 (42.58%)		

Author Computations; *p-value calculated by logistic regression analysis

DISCUSSION

The aim of the studywas to elaborate the risk factors related to DFUs in DM Type 2 patients. The data analysis shows that there was a multiple micro and macro vascular complications associated with DFUs. In the current study the prevalence of DFU was 50.0% and it is much higher than the global prevalence of diabetic foot ulcer, i.e., 6.3%. The diabetic foot ulcer was higher in males (71.4%) as compare to female (28.6%) and it is also much higher in global prevalence of males (4.5%) and females (3.5%) population of diabetic foot ulcer [10]. In the current study it was found that about 77.1% higher rate of having DFU who did not regular checkup of diabetic foot as compare to who did regular checkup (22.9%) and it is similar to another study results the proportion of usual care of DFU 13.3% much lower than the unusual care 25.4% (RR = 0.49, 95% CI, 0.28-0.84) [11]. These differences might be different study design, sampling techniques, sample size, different socio economic status, health related behaviors and quality of health system. T2DM patients had higher probability of developing DFUs as compare to other type of diabetes [12].Study have been reported that the burden of DFUs mostly in above 30 years of aged group and it is similar to current study the average age of diabetes patients was 58.44 years [13]. Results pertaining to diabetic foot ulcers with habits of smoking seem very interesting. The proportion of DFUs is higher in subjects with habitual of smoking as compared to those with non-smokers [14]. It is difficult to clarify the incidence of foot ulcers in view of the report that smoking does not seem to be risk factor for DFU. Study have been reported that multiple risk factors involved in the development of DFUs.Usually, long duration and uncontrolled diabetes are supposed to rise the chances of chronic complications [15]. Our results expose that over age, old diabetic patients, uneducated patients, habitual smoking and uncontrolled diabetes are separately associated risk factors for the growth of DFUs.Moreover, many patients had diabetes and foot ulcer for longer periods but ignored treatment or were not appropriately treated. They visited the clinic for the first time. A similar trend has been described from another country [15]. The previous studies reported that age, gender (male), co-morbidities like heart diseases, hypertension, and HbA1c are the main risk factors for DFUs [16]. It was identified that positive relationships for duration of diabetes, age and smoking habit with diabeticfootulcers. It has been advisedthat with avalue-added health education platformoffering guidanceon safety in the work and at home, physical examination (using special mirrorfor foot to examine feet may help), good hygiene and patients and healthcare providers may help to improve this infection.The primary prevention of diabetes related complications such as DFUs is to improve blood- glucose level [16-18]. Moreover, continuous monitoring of blood-glucose level is also essential for managing the DFUs. In present study showed, self-monitoring blood glucose was beneficial in managingfoot ulcer in all the diabeticpatients .Continuous foot checkupwasalso given to preventfoot infection. Other factors which can be causes of increased level of mood disorder like increase level of BMI, high level ofHbA1c, lowlevel of education, low level ofincome, gender, duration ofDM,marital status, other diabetic complications [19, 20].

CONCLUSIONS

Our study confirmed the there was a positive association between DFU with different factors and co-morbidity. In current study it was also found that the strong risk factors of DFU like over age, active smokers, long and uncontrolled duration of diabetes and low literacy rate. It is important that management of DFUs based on knowledge of the risk factors of DFUs. Moreover, it is most important to create awareness and education about diabetes and diabetes related complications, particularly amongst uneducated patients.

Authors Contribution

Conceptualization: SMA
Methodology: SMA, SMH
Formal analysis: SF
Writing, review and editing: SMA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

The authors declare no conflict of interest.

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Original Article

Effect of Moderate Intensity Exercise on Serum Ferritin Concentration

Aqib Ashraf[1], Zia Ul Islam[1], Alamgir Khan[2], Muhammad Jamil[3*], Hozaifa Bin Asif[2], Tasleem Arif[1], Shehzadi Sanam Roohi Farooqi[4], Rana Waqas[4], Noor Alam[4] and Zeliha Selamoglu[5]

[1]Department of Sports Science and Physical Education, University of Haripur, Haripur, Pakistan.
[2]Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan
[3] Centre for Physical Education, Health and Sport Sciences, University of Sindh, Jamshoro, Pakistan
[4] Department of Sports Sciences and Physical Education, Riphah International University, Faisalabad, Pakistan, Pakistan
[5]Department of Medical Biology, Medicine Faculty, Nigde Omer Halisdemir University, Nigde, Türkiye

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***Corresponding Author:**
Muhammad Jamil
Centre for Physical Education, Health and Sport Sciences, University of Sindh, Jamshoro, Pakistan
meharjamil88@gmail.com

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ABSTRACT

An iron-containing blood protein is called ferritin. The amount of iron stored in the body may be determined with this test. **Objective:** To evaluate the changes in serum ferritin concentration induced by moderate-intensity exercise for 12 weeks. **Methods:** Participants (n=20) for this study were selected through the developed inclusion and exclusion criteria which included age (18-25 years), BMI (18.5-24.9), and no chronic disease in participants and non-athletes. After the selection of participants, the participants were divided into two groups which were the control group (n=10) and the experimental group (n=10). After division only the experimental group was allowed to follow the 12-week exercise plan (intervention). Fresh blood samples of around (2-5 ml) were obtained in Ethylene-diamine-tetra-acetic Acid (EDTA) vacutainers using 5cc syringes with the help of the hospital paramedic staff. After the sample was collected, the sample was sent to a laboratory for further process of examination of serum ferritin concentration, which was done by professionals. **Results:** The data were analyzed and evaluated statistically using Version 22 of IBM SPSS software. Different tests including mean, paired sample t-test and independent samples t-test were applied to calculate the p-values of all studied groups. **Conclusions:** It was concluded that based on data analysis and findings, the researcher concluded that moderate-intensity exercise has a significant impact on serum ferritin concentration among the respondents.

INTRODUCTION

Ferritin is the first protein known to be involved in iron metabolism. Oswald Schmiedeberg a German pharmacologist, was the first to describe it in 1894 he noted that in horse liver there is an iron-rich component. But, in the year 1937 a Czech biologist named Vilém Laufberger purified the ferritin for the first time from horse spleen he suggested that it must be an element that serves as an iron store for the organism [1]. The protein known as ferritin is created by the cells of the human body, with a concentration mostly in the liver and immune system cells. Initially absorbing, storing, and subsequently releasing iron when required, also found vital in the production of red blood cells. By deficient iron, the human body cannot produce an adequate amount of haemoglobin, it is a crucial portion that helps the blood for oxygen circulation to human body organs as well as tissues [2]. Ferritin is an intracellular protein that stores, protects and releases iron in a controlled manner when needed [3]. It is produced by all living organisms. The quantity of ferritin in the blood is directly linked to the quantity of iron deposited in the body. Iron is required to make healthy red blood cells (RBCs). These cells transport oxygen to tissues and each organ of the body [4]. Ferritin is a different way to measure how much iron the body has overall and is the blood test of what's actually in the tissues [5]. The normal value of ferritin in humans ranges from 12-300 ng/ml in males and

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12-150 ng/ml in females [6]. Levels of serum ferritin are considerably lesser in persons with anaemia or undertaking phlebotomy. Insufficiency of ferritin results in iron-deficiency anemia which shows that a person has reduced RBCs in the body [1]. Ferritin has been compared to the bricks for the iron warehouse said Dr. Thomas DE Loughery. It depends on how much iron stores a person has in their body and how much ferritin seeps out into the tissues [7]. Ferritin is a 450 kDa hollow nano-cage with an exterior diameter of 12–13 nm and an inner diameter of 8 nm that may contain up to 4500 iron atoms in a form that is both non-lethal and bioavailable. There are 24 subunits present in each ferritin complex in mammals that create a sphere-shaped symmetrical protein shell [8]. In addition to being an intracellular version of ferritin, it is a crucial protein for blood flow. Serum ferritin is a kind of ferritin that was first discovered in 1948 in animals suffering from hepatic cirrhosis or shock. Later, in people with different forms of liver diseases, this initial finding was validated. Similar to ferritin samples taken from the spleen or liver, serum ferritin exhibited immunologic reactivity, molecular size, and isoelectric focusing properties. Additionally, serum ferritin had an astonishingly low iron content, only containing 4–20% of the iron found in liver or spleen ferritin. Even in patients with an excess of iron, this relatively low iron concentration persevered. Serum ferritin is a dependable gauge of iron stored in the body [9]. The normal value of ferritin in humans ranges from 12-300 ng/ml in males and 12-150 ng/ml in females. Levels of serum ferritin are considerably lesser in persons with anaemia or undertaking phlebotomy. Insufficiency of ferritin results in iron-deficiency anemia which shows that a person has reduced RBCs in the body [1]. As compared, serum ferritin levels were found greater in patients having iron-surplus disease and hemochromatosis. Serum ferritin is raised through prolonged and acute infection. C-reactive protein (CRP) and 1-acid glycoprotein are two other severe phase proteins whose levels have increased in correlation with their rise [9]. The acute role played by ferritin in the cellular and organismal homeostasis of iron is closely related to its major and best-studied function—iron sequestration. Iron in heme is compulsory for the transportation, binding, and oxygen release; the ready availability of iron for absorption into heme is necessary for the survival of organisms [10]. In recent times, it has become obvious that regulatory factors, in addition to those that regulate iron fluctuation, have an important effect on cellular ferritin. Ferritin can be noticed not simply as part of the iron regulatory proteins group, which contains transferrin and the transferrin receptor, but also as a protein family member that arranges cellular protection against stress and inflammation [11]. Exercise has been demonstrated to lessen stress and anxiety, as well as depressive symptoms. As a result, changes are made in the parts of the brain that regulate stress and anxiety. The neurotransmitters serotonin and norepinephrine, which diminish depression symptoms, may also be more readily available to the brain as a result of it [12-15]. Keeping in view, the above critical discussion now it is clear to say that exercise is basic tools which promote health and helps in avoiding health complications. Ferritin is a protein that helps store iron. What role is played by exercise with moderate intensity in serum ferritin concentration? The researchers intend to conduct this research study to discover this fact.

This research study aimed to examine the impact of moderate-intensity exercise on serum ferritin concentration.

METHODS

This study was conducted in the Department of Sports Sciences and Physical Education, University of the Punjab, Lahore Pakistan from Nov 2022 to July 2023. The ethical approval of this study was taken from the Ethical Committee of the Department of Sports Sciences & Physical Education, University of Punjab, Lahore, Pakistan (ref no.696/SPS) for conducting the study and likewise, the protocol of study complied with the Declaration of Helsinki. Before drawing the sample from the participants (a consent form was signed from each participant).An experimental research design was applied by the researcher. The participants for this study were 20 non-athlete students at the University of the Punjab Lahore, Pakistan. The participants of the study were divided into two groups i.e. control group (CG) and experimental group (EG). Each group was comprised of ten (10) subjects. The sample size was determined using G*Power statistical software based on Cohen's effect size conventions. Furthermore, the below criteria were used for the inclusion of participants. (1) The gender of the study participants was male. (2) The age group of study participants was 18-25 years. (3) Only physically fit participants with no chronic health complications were included in the study. Fresh blood samples of around (2-5 ml) were obtained in EDTA vacutainers using 5cc syringes with the help of the hospital paramedic staff. On the EDTA tube, the patient name, code, and date, must be written to maintain the record. Under the sterilized conditions, fresh samples were collected and stored at 4 °C to protect their integrity. Then these blood samples were sent to Citi Lab and Research Centre (CC HARIPUR-0) for lab work. The normal value of ferritin in humans ranges from 12-300 ng/ml in males and 12-150 ng/ml in females [16]. After the sample was collected, the sample was sent to a laboratory for further process of examination of serum ferritin concentration, which was done by professionals. A self-made exercise protocol of twelve weeks (12) weeks comprised of moderate-intensity exercise was applied to the experimental group. The Max heart formula was used for calculating the volume and intensity of exercise. To examine the pre-intervention test

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and post-intervention test difference, the pre-test and post-intervention data were analyzed using the appropriate descriptive statistical tools (mean and standard deviation) and inferential statistical techniques (paired sample t-test and independent sample t-test) in the statistical package for social sciences (SPSS, version-22).

RESULTS

The mean and standard deviation values of EG regarding the above-mentioned variables were serum ferritin 69.130 ± 49.8428. The mean and standard deviation values of EG regarding the above-mentioned variable were serum ferritin 47.330 ± 29.9190. The mean and std. values of serum ferritin (ng/ml) fitness for the experimental group (n=10) before and after intervention are shown in table 1.

Table 1: Pre and Post Serum Ferritin (ng/ml) level of Experimental Group (EG)

Pre-Intervention Variables of EG	N	Mean ± SD
Serum Ferritin (ng/ml) Pre	10	69.130 ± 49.8428
Serum Ferritin (ng/ml) Post	10	47.330 ± 29.9190

$\bar{X}$ = Mean, SD = Standard deviation

The mean and standard deviation values of CG regarding the above-mentioned variable were serum ferritin 58.619 ± 41.9684. The mean and standard deviation values of CG regarding the above-mentioned variable were serum ferritin 58.510 ± 41.3402. The mean and std. values of Serum Ferritin (ng/ml) for the control group before and after intervention are shown in table 2.

Table 2: Pre and Post Serum Ferritin (ng/ml) level of Control Group (CG)

Serum Ferritin (ng/ml)	N	Mean ± SD
Pre	10	58.619 ± 41.9684
Post	10	58.510 ± 41.3402

$\bar{X}$ = Mean, SD = Standard deviation

Furthermore, the table interprets; that there is no change in the CG & EG regarding the pre-test of serum ferritin. The values of serum ferritin pre-test of CG were (M = 58.6190, SD = 41.9684) and of EG (M = 69.1300, SD = 49.8428; t = 0.510, p=0.616> significant level = 0.05). Therefore, no significant difference was found in the status of serum ferritin of the control and experimental group before intervention. The independent sample t-test shows the comparison of serum ferritin control and the experimental group before intervention in table 3.

Table 3: Independent Sample t-test Showing the Comparison of the Pre-Test of the Control and Experimental Group Before the Intervention of Serum Albumin

Variable (Pre-Intervention)	Group	N	$\bar{X}$	Std.	*df*	*t*	p-values
Serum Ferritin (ng/ml)	EG	10	69.1300	49.8428	18	0.510	0.616
	CG	10	58.6190	41.9684			

Significant level = 0.05, CG = Control Group, EG= Experimental Group

A paired samples t-test showed the variance in EG Pre and Post-intervention characteristics of serum ferritin concentration. There was no significant change found in serum ferritin concentrations in pre and post-intervention tests in the experimental group, the pre-serum ferritin value was (M = 69.130, SD = 49.8428) to post-serum ferritin (M = 47.330, SD = 29.9190; t = 1.835, p=0.100> significant level = 0.05). Comparison of EG Pre and Post-intervention characteristics are shown in table 4.

Table 4: Paired Sample t-test Showing the Comparison of Serum Ferritin Pre and Post-Intervention Characteristics of the Experimental Group

Variables		$\bar{X}$	N	Std.	*df*	*t*	p-values
Pair 1	Serum Ferritin-pre	69.130	10	49.8428	9	1.835	0.100
	Serum Ferritin-post	47.330		29.9190			

Significant level = 0.05

DISCUSSION

This research study aimed to evaluate the "effect of moderate intensity exercise on serum ferritin concentration". Ferritin is the major protein in the human body that is responsible for many important functions including absorption, storage and release of iron [17]. Therefore, exercise is essential for the development of the body and prevents the human body from disease. This research study contributes to highlighting the impact of 12-week moderate-intensity exercise on serum ferritin concentration, with the age range of 18-25 years non-athlete male students [18]. The results show that there was no significant change found in serum ferritin concentrations in pre and post-intervention tests in the experimental group. The findings of this study were supported by findings of the study conducted by [19] that states that the level of iron increased significantly after exercise, and then decreased within the next 3 hours of restitution. Except for iron levels, only Total iron binding capacity (TIBC) levels significantly increased after exercise and decreased to baseline levels during the rest period. No significant changes in the levels of hepcidin, IL-6, and other proteins related to iron homeostasis were observed. also concluded that there was no significant effect of moderate-intensity exercise on serum ferritin levels. Exercise puts a lot of load on an athlete, especially in competitive sports, and accelerates the ageing of the erythrocytes. Exercise-induced changes in metabolic acidosis, body temperature, hypoglycemia, and haemoglobin concentration all lower erythrocyte osmotic resistance [20]. The study mentioned above also showed that moderate exercise caused an increase in plasma ferritin concentration, with the increase being greater as the intensity and duration of exercise increased. Return to the basal level was slower after maximal-intensity exercise than after moderate exercise.

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CONCLUSIONS

Based on data analysis and findings, the researcher concluded that moderate-intensity exercise has a significant impact on serum ferritin concentration among the respondents.

Authors Contribution

Conceptualization: AA, ZUI
Methodology: SSRF
Formal analysis: SSRF
Writing review and editing: AK, MJ, HBA, TA, RW, NA, ZS

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

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Original Article

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Nurse's Workload, Patient Safety and Quality of Care; A Descriptive Study in Tertiary Care Hospital

Saad Ur Rahman[1], Asif Mehmood[1], Irum Naz[1], Shaista[2*], Muhammad Ismail[1], Muhammad Adeel[1], Sana Gul[1], Muhammad Islam[3] and Minhaj Uddin[3]

[1]Department of Nursing, Mardan College of Nursing, Mardan, Pakistan
[2]Department of Nursing, Mardan College of Nursing, Bacha Khan Medical College, Mardan, Pakistan
[3]Department of Nursing, Medical Teaching Institution, Bacha Khan Medical College, Mardan, Pakistan

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***Corresponding Author:**
Shaista
Department of Nursing, Mardan College of Nursing, Bacha Khan Medical College, Mardan, Pakistan
eshal001swat@gmail.com

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ABSTRACT

The study was conducted on Registered Nurses at Mardan Medical Complex, Mardan Khyber Pakhtunkhwa. **Objective:** To explore the nurses' workload, its effect on patient safety and quality of care in Mardan Medical Complex, Mardan. **Methods:** A descriptive cross-sectional design was selected for the study. A sample size of 107 nurses was calculated through Raosoft software. For this, data collection tools consisted of a Demographic profile, the Maslach Burnout Scale, and the Nurses Report of Quality of Care. The collected data were analyzed through a Statistical Package of Social Sciences (SPSS) version 26.0 and Microsoft Excel. **Results:** On analysis of 115 structured questionnaire responses, the result disclosed most of the nurses were fed up with working all day long and delivered their maximum effort for their patients with the inappropriate number of staff. They rationalized their hard work with the belief in equality and providing care to humanity. With a high workload, they still feel satisfied and treat their patient apathetically. The nurses showed relatedness of poor quality of care to the high workload and low nurse-patient ratio. **Conclusions:** The nurses' workload has a direct effect on the patient's health. To maintain the quality of care, the nurse-patient ratio needs to be standardized. With an appropriate nurse-patient ratio, the nurses will then not prioritize the major intervention but will comprehensively and holistically care for their patients which will positively affect the quality of patient care.

INTRODUCTION

The workload of nurses is an essential issue that influences the quality of patient care worldwide. This issue has gained considerable notice from researchers due to its deep impact on patient safety. As universal demand for healthcare services grows, understanding how workload affects nursing care and patient outcomes. Nurses' workload has been identified as a major factor impacting patient safety and quality of care [1]. This workload has a rigorous impact on the provision and working of nurses in the prerequisite of care services in hospitals [2]. If a nurse suffers from burnout syndrome, the nursing care delivered to the patient will be compromised [3]. Workload prevents healthcare workers from doing their everyday jobs well, compromising patient safety [4, 5]. The workload of higher levels tends to be evaluated as poor patient safety in the specific work unit and generally in the hospital as a whole [6]. With such a burden, the nursing care for the patient is badly affected and the quality of nursing care which is the main focus of the nursing profession is compromised by stressful healthcare settings [7]. Workload has an undeviating connection with multiple factors associated with nurses and patients such as nursing care of low quality and patient safety [8]. Unfavorable outcomes arise due to workload among nurses closely related to patients, such as medication errors and nosocomial infections [9, 10]. Workload has always been a problem threatening nursing

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personnel and associated with nurse shortages all over the world. Globally, an 11.23% occurrence of workload among nurses was reported in a study in Namibia [11]. One of the researchers found that 15 Dutch ICUs were exposed to mortality related to the nursing workload [12]. Furthermore, a study in sub-Saharan Africa reported 33% burnout in nurses [11]. It was found that an increase in the workload of nurses by one patient increases patient mortality by 3.4%, and an increase in intention to leave by 10% causes an increase in patient mortality by 14% [13]. Nurses are considered the backbone of the hospital as they are the main personnel in the health care system [14]. The employment level is compromised both in developing and developed countries [15, 16]. In existing, for health care providers workload creates a stressful area to work especially impacting patient safety [17]. According to a study on European Nurses' Early Exit study performed by over 61,000 nurses, they were reported that 70% of the sample population mentioned heavy workloads as their main reason for planning to leave their jobs [18]. Workload strongly relates to the care provided for the patients and their safety [19]. Nurses from Khyber Pakhtunkhwa expressed that the work area of public tertiary care hospitals was fault-finding for practice [7]. The nurse-to-patient ratio varies from 1:3 for patients after surgical procedures to 1:1 for intensive care patients and 2:1 for demanding patients [12].

Moreover, it could lead to the provision of quality care and assess the impact of workload on patient safety and quality of care in tertiary care hospitals.

METHODS

A Descriptive Cross-sectional study was conducted with registered nurses through convenient sampling after IRB approval, from May to July 19, 2024. The ethical approval was taken from Mardan College of Nursing, BKMC Mardan (No. 2115/MCNM). Questionnaires were disturbed manually among those nurses who were willing to share their experiences and on duty Nurses of all units at Mardan Medical Complex (MMC) were included in the study. Exclusion criteria the nurses' ages above 35 years, on leave or and those who refused to participate were excluded from the study. The data were collected through convenient sampling and sample size was calculated on Rao Software: Margin error 7%, Confidence level 95%, Population size 230, Response distribution 50%, and Sample size 107. The data collection tools consisted of two parts; quantitative and qualitative variables. Quantitative variables of the study were Demographic factors i.e. age, gender, job title, qualification, position, hospital, domicile, experience, unit, and marital status and the 2nd Maslach Burnout Inventory (MBI) self-assessment tool of 7-Point Likert Scale tool with three subscales: Emotional Exhaustion (EE): Low (≤17), Moderate (18-29), High (≥30). Depersonalization (DP): Low (≤5), Moderate (6-11), High (≥12). Personal Accomplishment (PA): Low (≤33), Moderate (34-39), High (≥40). Burnout was indicated by high scores in EE and DP and low scores in PA. The qualitative variable were the Nurses' Reports of Quality of Care to assess the works load on nurses and patent quality care. It was a 13 questionnaire issued by Bruyneel 2009 used to find out the quality of care by collecting data from nurses. As it modified a 13-question modified questionnaire rated on a 4-point scale (Poor to Excellent and Never to Very Frequently). Responses with high frequencies for "Good" or "Often" indicated better quality of care. This modified tool was checked by three experts in the nursing field in MTI Mardan. The Crohn's Bach's alpha value for the MBI scale was 0.78 and Nurses' Reports of Quality of Care were calculated as 0.62 which were both reliable. The data were analyzed using SPSS version 26.0. The demographic and tool variables were entered into the software and converted to frequency and percentage maintains confidentiality. Frequency and percentage distributions were calculated for demographic characteristics such as age, gender, job title, qualifications, years of experience, unit of work, and marital status. Through Microsoft Excel 2020, the levels of burnout were categorized according to the mentioned criteria, and the total frequencies and percentages of the variables of quality of care were calculated.

RESULTS

A structured questionnaire was distributed manually among nurses in MMC, a tertiary care hospital in Khyber Pakhtunkhwa. A total of 115 nurses completed the questionnaire among which 38.3% were male and 61.7% were female. The marital status of participants varied in which 33.9% were married and 66.1% were unmarried. The qualification of the nurses comprises BSN, Post RN, and general nursing. Moreover, the positions of the nurses were divided into two categories; staff nurses held 87.0% while charge nurses took 13.0%. The service duration varied in which approximately 78.3% have less than 5 years, 14.8% have 5 to 8 years, and 7.0% have greater than 8 years of experience. The working areas were distributed into Critical areas including Medical and Surgical ICU, CCU, Pead's, and NICU, and General areas comprised of Medical and Surgical wards, Urology, ENT, Neurology, and chest ward as showed in table 1.

Table 1: Demographical Profile of the study Participants (n=115)

Variables	N (%)
Gender	
Male	44 (38.3%)
Female	71 (61.7%)
Marital Status	
Married	39 (33.9%)
Unmarried	76 (66.1%)

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Qualification	
General Nursing	18 (15.7%)
BSN	78 (67.8%)
Post RN	19 (16.5%)
Position	
Staff Nurse	100 (87.0%)
Charge Nurse	15 (13.0%)
Working Experience	
<5 Years	90 (78.3%)
5-8 Years	17 (14.8%)
>8 Years	8 (7.0%)
Working Areas	
Critical Areas	29 (25.2%)
General Wards	86 (74.8%)

According to the MBI scale, the analysis of the responses shows that most of the participants marked moderate to high burnout in the first two sections while in section C, the majority marked low burnout. As per the criteria, these high scores in the first two sections with lower scores in section C indicate "Burnout "which addresses the high workload on nurses as showed in Table 2. Nurses reported through the structured questionnaire as being stressed and fed up with their greater efforts while working with the patients all day long. They were very enthusiastic about their work and they build a therapeutic relationship with the patient which helps them to understand the problems and this relationship helps the patient to freely explain their problems. Therefore, the nurse looks after the problems of the patients effectively and shows a positive effect on the people and thus it makes them satisfied with their job and duty.

Table 2: Maslach Burnout Inventory (MBI)

MBI Scale	Low Burnout N (%)	Moderate Burnout N (%)	High-level Burnout N (%)
Section A (Emotional Exhaustion)	18 (15.7%)	62 (53.9%)	35 (30.4%)
Section B (Depersonalization)	0	07(6.1%)	108 (93.9%)
Section C (Personal Accomplishment)	86 (74.8%)	15 (13.0%)	14 (12.2%)
Total Responses	115 (100%)	115 (100%)	115 (100%)

Regarding the Quality care report by nurses of different wards in the hospital, about half of the participants showed satisfactory results and rated the care that was delivered in their unit as Good. The infection control protocols were followed by the staff which leads to quality care of the patient and also leads to overcoming their stay in the hospital but still, the staff was not satisfied with the staffing ratio of this hospital and they believe that such staffing can compromise quality care. Despite the overload at the wards, the staff managed the medication errors very effectively and also had good control over nosocomial infections in addition to this the ratio of patient falls was very low. Due to inappropriate staffing ratio, nurses have to prioritize the care and sometimes they prefer to skip the care due to its least requirement because of limited resources and work overload as mentioned in table 3.

Table 3: Nurses' Reports of Quality of Care, Recommendations and Patient Outcomes

Items Summary	Poor N (%)	Good N (%)	Very Good N (%)	Excellent N (%)
Patient Quality of Care in the Concerned Unit/Ward	08 (7.0%)	55 (47.8%)	28 (24.3%)	24 (20.9%)
Summary	**Never**	**Often**	**Frequently**	**Very Frequently**
Following Control Infection Protocols	14 (12.2%)	44 (38.3%)	46 (40.0%)	11 (9.6%)
Recognizing the Impact of Quality of Care on Patient Outcomes	5 (4.3%)	34 (29.6%)	60 (52.2%)	16 (13.9%)
With the Current Staffing Level, an Appropriate Time for Providing Quality Nursing Care to each Patient	19 (16.5%)	47 (40.9%)	34 (29.6%)	15 (13.0%)
Frequency of Medication Errors	39 (33.9%)	47 (40.9%)	18 (15.7%)	11 (9.6%)
Frequency of Pressure Ulcers	36 (31.3%)	44 (38.3%)	22 (19.1%)	13 (11.3%)
Frequency of Patient Falls	44 (38.3%)	35 (30.4%)	20 (17.4%)	16 (13.9%)
Frequency of UTIs	27 (23.5%)	41 (35.7%)	30 (26.1%)	17 (14.8%)
Frequency of Bloodstream Infection	35 (30.4%)	41 (35.7%)	26 (22.6%)	13 (11.3%)
Communication Challenges with Patients due to Limited Interaction Time	12 (10.4%)	36 (31.3%)	43 (37.4%)	24 (20.9%)
Limited Resources Negatively Impact your Nursing Care to a Patient	12 (10.4%)	36 (31.3%)	36 (31.3%)	31 (27.0%)
Prioritize Tasks due to Time Limitations	17 (14.8%)	35 (30.4%)	38 (33.0%)	25 (21.7%)
Compromise Patient Care due to Staffing Shortage	13 (11.3%)	32 (27.8%)	35 (30.4%)	35 (30.4%)

DISCUSSION

This descriptive study examines how nurse workloads affect patient care. Increased workload lead to burnout, characterize by emotional exhaustion and depersonalization, which negatively impacted patient safety due to staffing shortages and low job satisfaction. Low staffing ratios were identified as a key factor in high workloads. Even with this challenge, nurse's shows loyalty to infection prevention and report that their work made them more aware and caring toward others. In looking back at the literature, the long day of work and high patient flow were reported to contribute to the workload of the nurses [13-15]. In support of this finding, another study also explored the association of high workload with poor quality of care and vulnerability to patient safety [16-18]. In the present study, the participants reported that they prioritized their intervention due to limited staff and high patient flow. This was supported by literature where the investigator points out the same finding that patient care was delayed or incomplete due to the nurse-patient ratio [19]. The literature supports the reported exhaustion of participants as nurses feel fatigued and unable to provide

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standardized care to each patient which worsens the quality of care and was contributed by a shortage of nursing staff [20]. This fatigue and overwhelming lead to compromised nursing care, stress and burnout in staff, and overall low job satisfaction as mentioned in previous studies [21]. On the other side, a meta-analysis concluded that communication skills and interaction with the patients affect the quality of care [22]. Moreover, one of the studies summarizes the findings that a positive cultural environment for work and enough resources in the institutes with appropriate staffing ratios can improve patient quality of care and safety in the health care system [23]. The participants of the current study with the increased workload still tried to provide quality care and were successful in minimizing adverse events like medication errors and patient falls. Contrary to this finding, a study conducted in Jordan showed a linkage between increased workload and adverse events like medication errors [24]. Besides the above discussion, this study has some limitations. The participants of the study were taken from one tertiary care hospital. The workload and quality of care were pointed out through the mentioned two scales. Furthermore, the study displayed the responses of workload, patient safety, and quality of care of the participants collectively without any categorization. Further research was needed in similar domains to analyze findings with gender base classification and of different units separately. Also, other validated tools were needed for quantifying the nurses' workload and patient safety for better outcomes.

CONCLUSIONS

The major depressing correlation among nurses' emotional exhaustion and depersonalization with quality of care scores show up the damaging impact of workload on patient safety. This result support the study's objective to investigate the relationship between nurse workload and the quality of care provide. Address burnout and civilizing workload managing were the vital to boost both nurse well-being and patient outcome, finally encouraging a safer healthcare environment.

Authors Contribution

Conceptualization: S
Methodology: SUR, AM, MI, MA, SG
Formal analysis: MI, MU
Writing, review and editing: SUR, IN, S

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Original Article

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Stepping Forward: Evaluating the Impact of Gait Training on Post-Stroke Patients' Energy Cost of Walking: A Pre-Test Post-Test Analysis

Ifrah Masood[1], Rabia Masood[2], Salman Farooqi[3*], and Forhad Hussain Apu[4]

[1]Department of Allied Health, the Superior University, Lahore, Pakistan
[2]Department of Oral Pathology, Dental College HITEC IMS, Taxila, Pakistan
[3]Institute of Physical Medicine and Rehabilitation, Khyber Medical University, Peshawar, Pakistan
[4]Department of Neurosurgery, Xuanwu Hospital, Capital University of Beijing, China

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***Corresponding Author:**
Salman Farooqi
Institute of Physical Medicine and Rehabilitation, Khyber Medical University, Peshawar, Pakistan
salman.farooqi@kmu.edu.pk

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ABSTRACT

Stroke is a leading cause of disability and death globally, increasingly affecting younger populations and presenting significant rehabilitation challenges, particularly in restoring independent ambulation. Despite the established impact of energy cost on walking performance, the specific effects of gait training interventions on walking economy remain underexplored. **Objectives:** To examine the effectiveness of an intensive gait training exercise intervention on Energy cost of walking (ECW) and ambulatory performance in chronic stroke patients. **Methods:** A randomized controlled trial (Clinical trial ID: IRCT20211011052727N2) was conducted from Apr 2023 to Nov 2023, in which fifty-eight chronic stroke patients, aged over 18 and being able to walk 14 meters with or without walking aids, were recruited for this design. The key outcome measures were the Physiological cost index, 10 meter walk test, Fugl-Myer Assessment and the 6-minute walk test. Patient received six weeks of gait training exercise intervention at a university rehabilitation center. Outcome evaluations were conducted at bassline, as well as at two, four and six-weeks post intervention. **Results:** The mean Physiological cost index (PCI) score at baseline was 0.73 ± 0.37 beats/min, was found significantly different from Post intervention score 0.56 ± 0.30 beats/min ($F=52.32$ $p<0.01$). Similarly, significant differences were noted in walking speed and walking endurance post intervention ($p< 0.05$). Post hoc Tukey's multiple compression showed significant improvement in walking economy at 2 weeks ($p<0.05$), 4 weeks ($p<0.01$) and 6 weeks ($p<0.01$). **Conclusions:** Gait training exercises may significantly improve walking economy, ambulatory speed, and endurance in chronic stroke patients over a six-week intervention.

INTRODUCTION

Stroke is the third leading cause of disability and the second most common cause of death Globally [1]. Its prevalence is getting higher worldwide predominantly among younger and middle-aged population. Approximately 33% of stroke patients are under the age of 65 challenging the traditional belief that stroke primarily affects the elderly [2]. The incidence of stroke is also increasing in developing countries, with prevalence rates in KPK, Pakistan ranging from 1.2% to 19% [3, 4]. Post-stroke patients often encounter a range of complications, with the primary concern being the loss of independent ambulation within the community [5]. The central objective of stroke rehabilitation is to restore autonomous walking abilities, but several factors hinder this capability, including diminished motor performance, balance issues, and muscle weakness [6-8]. Stroke survivors frequently struggle with ambulation due to the burden of the paretic limb, which leads to increased energy expenditure [9]. Gait training is a primary component of rehabilitation, helping patients to achieve functional ambulation and to minimize the energy cost of walking (ECW). ECW is typically higher in stroke survivors because of abnormal gait, muscle weakness as well as associated compensatory movements that reduce endurance in those affected. Such difficulties considerably risk the capacity to carry out common tasks and regain basic mobility. Other techniques for containing

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and treating neuromuscular disorders include body weight support treadmill training, muscle strengthening and balance training, and cognitive-motor training, which helps to enhance neuromuscular coordination as well as gait symmetry. While individuals without stroke consumes approximately half of their maximal aerobic capacity during walking, on the other hand stroke patients expend around 75% [10]. Previous studies have established the influence of energy cost of walking (ECW) on comfortable gait speed (CGS) and walking endurance and found curvilinear relationship between 6-minute walk test (6MWT) and 10 meter walk test (10MWT) However, the specific impact of gait training interventions on ECW and walking performance remains underexplored [11, 12]. the current research incorporates Physiological Cost Index (PCI), a validated measure based on heart rate and walking speed, alongside other functional measures such as the 10-Meter Walk Test (10MWT) and the 6-Minute Walk Test (6MWT) to evaluate the hypothesis that patients will exhibit improved walking economy following the intensive gait training exercise intervention.

This study aimed to investigate the efficacy of a comprehensive gait training exercise intervention on ECW and walking performance over a six-week period.

METHODS

This Randomized controlled trial study was conducted in a university rehabilitation center between April to November 2023. (Trial registration number: IRCT20211011052727N2). A total of 54 chronic stroke patients were enrolled for this study. The selection criteria for inclusion of the participants were: male and female stroke patients aged 18 or above; being able to walk independently or with the help of walking aids up to 14 meters; having functional ambulatory category score of 3 or more; stroke onset at least 6 months ago before the start of the study; cognitively stable patients with a score of 24 or above on the mini mental status examination. Patients were excluded if they had a recurrent stroke, uncontrolled hypertension, and unstable heart diseases. This study followed the ethical guidelines of the Helsinki Declaration. Ethical approval was granted by Institutional ethical review board (KMU/EB/ER 22-09/093). Participants were provided with an information sheet and signed informed consent before the start of the study. For sample size calculation G*Power (version 3.1) was employed. A medium effect size of 0.25 was assumed, with a significance level of (alpha) 0.05, and power of 0.95. the study design consists of a single group with 4 repeated measures with a correlation of 0.22 and a non-centrality parameter ( ) of 18.58. The critical F value was 2.77, with the numerator and denominator degrees of freedom being 3 and 55, respectively. Based on these parameters, sample size was calculated to be 54. To calculate the ECW, we utilized the Physiological Cost Index (PCI). The PCI has been validated as a reliable tool for assessing the energy cost of walking, particularly in individuals with neurological impairments, including stroke survivors [13]. The formula of PCI based ECW calculation is as follow,

$$\text{PCI beats/m} = \frac{\text{Walking HR - Resting HR}}{\text{Walking Speed m/min}}$$

The 10MWT was used to assess the CGS of the recruited patients. The 10MWT is a valid and reliable tool for determining the walking speed of chronic stroke patients. Walking endurance was evaluated utilizing the 6MWT. The patient's motor performance was examined with the help of the Fugl-Meyer Assessment [14]. Moreover, functional ambulatory independence was assessed using the Functional ambulatory Category (FAC), and cognitive stability was checked employing the mini-status mental examination (MMSE) [15]. All the outcome measures are well-established, reliable, and valid tools for their respective purposes in chronic stroke patients. Gait training exercises were given to the participants 3 times/week for a total duration of 6 weeks, the duration for each session lasted for 60 minutes and involved several components designed to address various aspects of gait and functional mobility. The intervention included 1)Body weight supported treadmill training, Participants engaged in 15 minutes of treadmill walking with body weight support, performed at a comfortable gait speed 2)Parallel bar gait Training, Participants were instructed to walk forward, backward and sideways inside the parallel bar for 10 minutes 3) participants were given targeted muscle group strengthening 4) lower limb range of motion exercises 5) balance and proprioception training 6) cognitive-motor integration exercises. Participants were given rest period of 15 minutes after treadmill and parallel bar walking. The PCI calculation was conducted at 4-time points, at baselines, and subsequently at weeks 2, 4, and 6 post-interventions. Moreover, CGS, walking endurance, and motor performance were evaluated at these same intervals. The HR measurements were recorded using the Polar H10 sensor (Kempele, Finland) equipped with a Pro strap. To ensure the precision of the PCI measurements, participants were instructed to refrain from caffeinated drinks and chocolates on the days of each evaluation. Upon arrival at the rehabilitation center, patients were asked to rest in a chair for 15 minutes to stabilize their HR. Besides the HR data obtained with the Polar H10 sensor, other patients' vital signs such as blood pressure, respiration rate, and oxygen saturation were also monitored before, during and after each therapy session to guarantee safety. Any abnormal fluctuation in these vital signs during therapy sessions were corrected by either lessening the intensity of the therapy or going ahead to provide a break as was appropriate. All mentioned types of monitoring were conducted under the supervision of a licensed physical therapist to reduce the risks for the patients and achieve

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the best results of the therapy. Ample water was provided to ensure proper hydration throughout the evaluation process. Data analysis was performed using GraphPad Prism version 9.5. Descriptive statistics were computed for univariate variables such as age, BMI, and stroke onset, and results were presented as means and standard deviations. To assess the effectiveness of the gait training exercise intervention, a repeated measures one-way ANOVA was conducted. This was followed by Tukey's post hoc multiple comparison test to determine specific differences between groups. The critical alpha level for statistical significance was set at $p<0.05$.

RESULTS

The average age of the patients was 56.22 ± 6.84 years with a mean stroke onset of 8.92 ± 3.63 months. sixty-one percent of the included participants were male and 39% were female. Detailed demographic characteristics including stroke types, hemispheric involvement, and FAC scores, are provided in table 1.

Table 1: The Demographic/ Functional Characteristics

Demographic Characteristics N = 54	
Age (Y)	56.22 ± 6.84
BMI (kg/m^2)	27.34 ± 5.36
Stroke Onset (m)	8.92 ± 3.63
Gender N (%)	
Male	33 (61)
Female	21 (39)
Type of Stroke N (%)	
Ischemic Stroke	38 (70)
Thrombotic Stroke	24 (44)
Embolic Stroke	14 (26)
Hemorrhagic Stroke	16 (30)
Intracerebral Hemorrhage	13 (24)
Subarachnoid Hemorrhage	3 (6)
Effected Side N (%)	
Right Hemispheric Stroke	33 (62)
Left Hemispheric Stroke	21 (38)
FAC Score N (%)	
4	23 (42)
<4	31 (58)

Note: values are mentioned as mean standard deviations and number of patients and percent of the whole cohort. Abbreviation: y, years; m, months; kg/m^2, kilograms per square.

The mean Pre-Intervention PCI score was 0.73 ± 0.37, while the Post Intervention PCI score was 0.56 ± 0.30. This resulted in an F-value of 52.32 with a $p<0.01$ indicating a statistically significant change. Similar analyses were conducted for the 10MWT, the 6MWT, and the FMA-LE, as detailed in table 2.

Table 2: Pre and Post Intervention Analysis

Variables	Pre-Intervention	Post Intervention Week 2	Post Intervention Week 4	Post Intervention Week 6	F	p-Value
PCI (beats /min)	0.73 ± 0.37	0.68 ± 0.33	0.62 ± 0.31	0.56 ± 0.30	52.32	<0.01
10MWT (m/s)	0.47 ± 0.23	0.51 ± 0.19	0.56 ± 0.21	0.58 ± 0.21	42.48	<0.01
6MWT (m)	195.5 ± 72.61	197.7 ± 72.98	200 ± 74.54	205.5 ± 78.08	38.56	<0.01
FMA-LE	19.85 ± 2.84	19.91 ± 2.97	20.1 ± 3.33	20.4 ± 3.23	22.44	>0.05

Note values are Mean ± S.D, P value calculated between pre intervention and post intervention using repeated measure one-way Anova. Abbreviations; PCI, Physiological Cost Index; FMA-LE, Fugl-Meyer Assessment- lower extremity; 10MWT, 10 meter walk test; 6MWT, 6-minute walk test; beats/min, beats per minute; m/s, meter per second; m, meters.

The results revealed significant improvements in both the 10MWT and 6MWT with p-values <0.05. In contrast the FMA-LE did not show statistically significant changes with a $p>0.05$. Given the significant findings for PCI, 10MWT and 6MWT in the repeated measures ANOVA we performed the Tukey's multiple comparison test (post hoc analysis). Significant differences were observed in the PCI scores of stroke patients at 2 weeks ($p<0.05$), 4 weeks ($p<0.01$), and 6 weeks ($p<0.01$) post-intervention. The detailed comparisons are illustrated in figure 1.

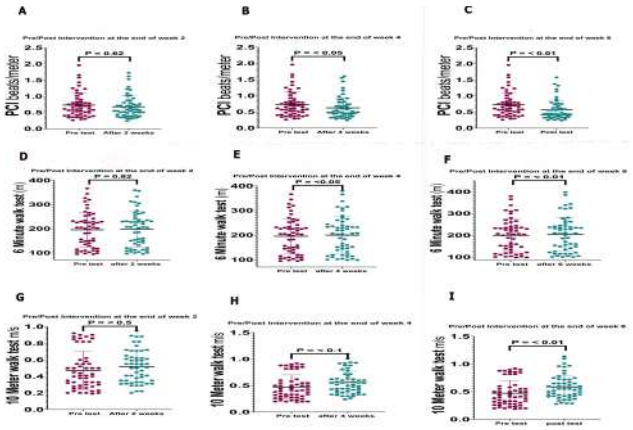

Figure 1: Post Hoc analyses using Tukey's multiple comparison test are depicted in panels A through I. A show the comparison between Pre-Intervention and 2 weeks Post Intervention for PCI values. B illustrates the comparison between Pre-Intervention and 4 weeks Post Intervention PCI values. C presents the comparison between Pre-Intervention and 6 weeks Post Intervention PCI values. D compares Pre-Intervention with 2 weeks Post Intervention for 6MWT distance (meters). E shows the comparison between Pre-Intervention and 4 weeks Post Intervention 6MWT distance (meters). F depicts the comparison between Pre-Intervention and 6 weeks Post Intervention 6MWT distance (meters). G illustrates the comparison between Pre-Intervention and 2 weeks Post Intervention for 10MWT (m/s). H compares Pre-Intervention with 4 weeks Post Intervention 10MWT (m/s). I show the comparison between Pre-Intervention and 6 weeks Post Intervention 10MWT (m/s).

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DISCUSSION

The findings of current study underscore the efficacy of gait training exercises in enhancing both walking economy, walking speed, and endurance among chronic stroke patients. As hypothesized, the results demonstrate that a six-week gait training intervention significantly improves walking economy. While no significant changes in ECW were observed at two weeks post-intervention, a notable reduction in ECW was recorded at both four- and six-weeks post intervention. This finding aligns with recent research suggesting that gait interventions extending beyond four weeks are more effective in enhancing gait speed and endurance compared to shorter interventions [16]. Moreover, this prior study did not evaluate ECW, which is a critical aspect of current investigation. Present study also revealed a significant improvement ($p<0.05$) in walking speed from four to six weeks post-intervention. Earlier studies have established walking speed as a crucial predictor of walking economy [17]. Furthermore, walking speed is instrumental in categorizing individuals into different levels of ambulatory ability such as household ambulators (<0.4 m/s), limited community ambulators (0.4-0.8 m/s), and community ambulators (>0.8 m/s) [18]. In terms of walking endurance, as assessed by the 6MWT, current cohort demonstrated a significant improvement in distance traveled compared to baseline following the six-week intervention. The 6MWT score is a key predictor of community ambulation post-stroke and is vital for assessing walking endurance. Previous studies have indicated that chronic stroke patients who achieve a 6MWT score >205 meters are considered independent community ambulators. Based on this criterion, the patients improved from a mean distance of 195 meters (limited community ambulators) to over 205 meters (independent community ambulators) [19]. However, no significant differences were observed in motor performance, as measured by the FMA-LE, following the six-week gait training intervention. Prior research suggests that a motor performance score >21 is necessary for ambulation, but since the FMA-LE encompasses a range of motor parameters beyond gait performance, other factors may influence overall motor performance [20]. This study represents a pioneering effort in evaluating the impact of a comprehensive gait training exercise intervention on ECW in stroke patients. The strengths of this research include its broad and multidimensional exercise approach, which benefits patients' overall functional outcomes. Nonetheless, a limitation of current study is the absence of a control group. Given that gait training is an integral component of stroke rehabilitation, excluding a control group would have violated the ethical principles of beneficence and non-maleficence. Additionally, we permitted the use of assistive devices during evaluations to support patient safety, although this may have influenced the results.

CONCLUSIONS

In conclusion, current study indicates that gait training exercise intervention may significantly improve walking economy, speed, and endurance in stroke patients following a six-week regimen. These improvements suggest that incorporating gait training into post-stroke rehabilitation could offer substantial benefits, potentially enabling patients to achieve a level of ambulatory independence required for navigating their communities more effectively.

Authors Contribution

Conceptualization: SF, FHA
Methodology: IM
Formal analysis: MI, RM
Writing review and editing: IM, RM, SF, FHA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

The authors declare no conflict of interest.

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Understanding the Trends and Implications of Vitamin B12 Supplementation in Lahore, Pakistan: An Exploratory Study

Irzah Farooq[1*] and Javeria Saleem[1]

[1]Department of Public Health, University of the Punjab, Lahore, Pakistan

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***Corresponding Author:**
Irzah Farooq
Department of Public Health, University of the Punjab, Lahore, Pakistan
irzahfarooq@gmail.com

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ABSTRACT

Vitamin B12 plays a critical role in building muscle strength, the nervous system and general healthiness. But over the past few years, it has been overused and, in some cases, abused due to self-medication, being prescribed to too many people, and being marketed too aggressively by drug companies. **Objectives:** To explore how both healthcare professionals and patients in Pakistan perceive and use vitamin B12 supplements, with a specific focus on understanding the factors contributing to their overuse and related health concerns. **Methods:** In a qualitative explorative research design, 20 healthcare professionals of 5 different medical disciplines and 17 patients who have taken vitamin B12 supplements within the last year were interviewed in-depth. Key patterns in knowledge, prescribing behaviours, self-medication practices, and awareness of safety were identified by means of thematic analysis. **Results:** Vitamin B12 was deemed safe by both doctors and patients in general. The doctors acknowledged giving prescriptions under patient pressure or being influenced by pharma, whereas the patients mentioned social media, peer recommendation, and availability of supplements as major contributors. There was little information on how much could be taken and of the side effects and risks, and little follow-up was done following its intake. **Conclusions:** The popularity and generally non-regulated spread of vitamin B12 use in Pakistan suggest incomplete awareness, clinical practice and policy. The national guidelines, improved education to prescribers, popularization of mass awareness, and regulation of supplement marketing are urgently needed to make their use responsible and safe.

INTRODUCTION

Vitamin B12 is a highly important water-soluble vitamin also known as cobalamin. It is a vital component in various processes in the body, such as the making of red blood cells, functioning of the nervous system and DNA synthesis [1, 2]. It is structurally the most complicated vitamin and comprises a corrin ring that has cobalt [3]. Lack of vitamin B12 may cause megaloblastic anemia, neurological disabilities, and cognitive disabilities [4, 5]. It is usually regarded as safe, but new studies indicate possible cardiovascular disease risks and some cancers in excess amounts in people not deficient in the substance [6, 7]. Compared to other vitamins, only certain bacteria can produce vitamin B12, including Propionibacterium shermanii and Pseudomonas denitrificans, so they are the main animal products supplying vitamin B12 to humans, i.e., meat, dairy products, fish, and eggs [8]. Hematopoiesis, the integrity of myelin sheath, and replication of DNA, especially in rapidly dividing cells, require it [9, 10]. There is a deficiency in vegans, vegetarians, as well as patients with malabsorption problems such as Celiac disease, Crohn's disease or those who have undergone surgeries of their gastrointestinal tract [11]. Use of long-term medications such as metformin and proton pump inhibitors disrupts the absorption of B 12 as well [12]. Laboratory results showing signs and symptoms of B12 deficiency include fatigue, pallor, paresthesia, balance problems, deteriorated thinking ability, glossitis, irritability, and megaloblastic anemia [13]. Oral (500 to 2000 mcg/day), sublingual and

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intramuscular injection (usually a 1000 mcg dose to treat deficiency) are all common methods of supplementation [14]. Although this substance is soluble in water, when taken in excess by non-deficient people, it has raised some concerns, such as acneiform eruptions, rosacea, and the chance of developing cancer [7]. Excessive use of injectable B12 without any diagnosis is among the issues regarding public health in countries such as Pakistan and India. Among the drivers of supplement use, there are unregulated access to supplements, intense pharmaceutical marketing, insufficient clinic guidelines, and insufficient awareness on the part of patients and medical practitioners [15]. To avoid unreasonable risks to the population and excessive spending, the pathway the efforts is a test of the necessity of filling people with national prescribing protocols and improving the level of education on the population level in terms of public health knowledge.

This study aimsedto explore how both healthcare professionals and patients in Pakistan perceive and use vitamin B12 supplements, with a specific focus on understanding the factors contributing to their overuse and related health concerns.

METHODS

This qualitative exploratory study, grounded in an interpretivist framework, aimed to deeply understand how people in Lahore, both healthcare professionals and patients, perceive and engage with vitamin B12 supplementation. Data were collected from different areas of Lahore. Led by a public health postgraduate student trained in qualitative interviewing, the research sought to capture real-life experiences through face-to-face conversations with 20 doctors from different specialities and 17 patients who had used B12 in the past year. The researcher maintained a reflexive journal to stay aware of personal biases and approached participants through referrals and professional networks, ensuring informed consent and comfort throughout. Interviews, conducted between January and March 2025, were rich and in-depth, allowing participants to share openly. These conversations were transcribed, translated, and analyzed thematically using Braun and Clarke's method, with insights carefully organized to reflect the nuances in both doctor and patient experiences. Data saturation was achieved once no new themes emerged, and ethical principles like confidentiality and anonymity were strictly maintained.

RESULTS

20 doctors from different specialities were recruited for the study, and face-to-face interviews were conducted. By analyzing the interviews of these doctors, the following codes, sub-themes/categories and themes were extracted. Analysis of the sociodemographic data showed that Gynaecologists and orthopedic doctors frequently prescribed vitamin B12 for routine symptoms without lab confirmation, while nephrologists and psychiatrists emphasized follow-up challenges due to complex cases. Younger doctors (under 10 years of experience) appeared more influenced by pharmaceutical marketing, unlike senior clinicians who relied more on clinical judgment. These trends highlight how speciality and experience shape prescribing behaviour (Table 1).

Table 1: Sociodemographic Characteristics of Doctors

Participant	Sector	Specialty	Gender	Experience
D01	Private	Gynecology	Female	10 years
D02	Public	Orthopedics	Male	12 years
D03	Private	Pediatrics	Female	7 years
D04	Private	Psychiatry	Male	8 years
D05	Public	Nephrology	Female	5 years
D06	Private	Gynecology	Female	6 years
D07	Private	Orthopedics	Male	9 years
D08	Public	Pediatrics	Female	11 years
D09	Private	Psychiatry	Male	6 years
D10	Private	Nephrology	Female	13 years
D11	Public	Gynecology	Female	15 years
D12	Private	Orthopedics	Male	10 years
D13	Private	Pediatrics	Female	4 years
D14	Public	Psychiatry	Male	7 years
D15	Private	Nephrology	Female	9 years
D16	Private	Orthopedics	Male	8 years
D17	Private	Physiotherapy	Male	5 years
D18	Public	Urology	Male	12 years
D19	Public	Orthopedics	Male	18 years
D20	Private	Psychiatry	Female	8 years

The following core themes are extracted from codes, and a thick description of these core themes was developed by repeatedly reviewing the interview transcripts. Prescription of Supplements Without any Diagnostic Confirmation was frequently reported by doctors, many of whom admitted to prescribing vitamin B12 regularly based on general symptoms. As one doctor explained, "Patients rarely agree to do the test, and most can't afford it, so we prescribe based on symptoms." (D07). The emphasis was often on symptom relief rather than diagnostic accuracy: "If they feel better after the injection, what's the harm? That's enough for me." (D18). Another major theme was the Influence of Marketing Strategies by Pharmaceutical Companies, with nearly all doctors agreeing that pharmaceutical marketing heavily influences prescribing habits. Medical reps frequently provide free samples and promotional materials that highlight B12's benefits. "The reps frequently visit and give promotional material. It creates an impression that B12 can help everyone, so we tend to use it more often." (D14). Additionally, marketing affects patients directly, with some requesting specific

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brands after exposure to social media or television ads: "Sometimes patients even ask for a specific brand they've heard about. I think the marketing is working on both ends." (D03). The Perception of Vitamin B12 as a Harmless Nutrient further normalized its widespread use, as none of the doctors reported concerns about toxicity or potential side effects. "It's not like a drug; it's just a vitamin. It won't harm them even if they don't need it." (D20). The Lack of Uniform Guidelines also contributed to inconsistent practices, as doctors reported no clear national or institutional protocols. "There's no single protocol for all; each doctor does what they feel is right." (D10). Many doctors acknowledged relying on peer advice instead of structured guidance: "There's no one telling us the exact dosing, so we just go with what we've seen others doing." (D08). Finally, Routine Use in Chronic Conditions was widely reported, with B12 prescribed regularly to patients with diabetes, menstrual irregularities, pregnancy, or neuropathies even in the absence of diagnostic evidence. "In diabetic patients or during pregnancy, I usually include B12 without thinking twice. It's safe and helps with symptoms." (D06). This routine prescribing stems from both clinical experience and the belief in the supplement's broad safety margin, making B12 a common, almost automatic part of chronic care in Pakistan (Figure 1).

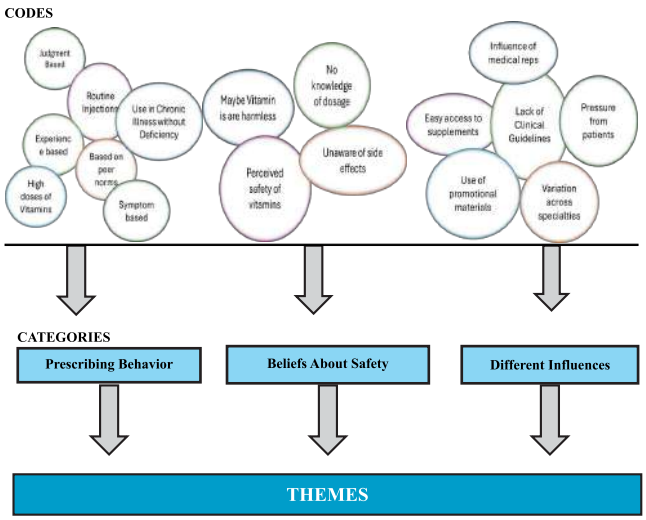

Figure 1: Visual Representation of Coding Tree and Thematic Analysis of Interviews of Doctors

17 patients suffering from different diseases related to gynae, bone-related issues, patients with chronic and acute kidney disease, patients on lifelong dialysis, and those with kidney stones, also patients suffering from any psych disorder like depression, anxiety, or bipolar diseases, overall fatigue and weakness were recruited for the study and were interviewed. A demographic overview of all the patients who participated in the study was presented (Table 2).

Table 2: Sociodemographic Characteristics of Patients (n=17)

Code	Age	Gender	Form of Supplement	Prescribed or Self	Duration	Condition
P01	30	Female	Injection	Prescribed	6 months	Joint Pain
P02	45	Male	Tablet	Self-medicated	1 year	Fatigue
P03	29	Female	Tablet	Self-medicated	3 months	Weakness
P04	50	Female	Injection	Prescribed	8 months	Bone Pain
P05	36	Male	Injection	Prescribed	2 months	Neuropathy
P06	32	Female	Injection	Self-medicated	4 months	Back Pain
P07	27	Male	Tablet	Self-medicated	1 year	Fatigue
P08	40	Female	Injection	Prescribed	6 months	Pernicious anemia
P09	34	Female	Tablet	Self-medicated	5 months	Menstrual Irregularities
P10	41	Male	Injection	Prescribed	3 months	Diabetic Neuropathy
P11	38	Female	Injection	Self-medicated	7 months	Body Weakness
P12	33	Female	Injection	Self-medicated	6 months	Tiredness
P13	48	Male	Tablet	Prescribed	9 months	Gastric Ulcer
P14	35	Female	Tablet & Injection	Self-medicated	1 year	General Weakness
P15	28	Female	Injection	Prescribed	2 months	Joint Aches
P16	43	Male	Injection	Prescribed	4 months	Memory Issues
P17	37	Female	Tablet	Self-medicated	5 months	Fatigue & Mood Swings

These interviews were translated and transcribed. Then a thematic Analysis was performed, and different codes, sub-themes, and themes were extracted from them. Among patients, female participants in their 30s–40s commonly used B12 for fatigue and menstrual issues, often influenced by peer or social media advice. Male patients over 40 preferred injections, perceiving them as more effective. Younger patients (<35) cited platforms like YouTube and Instagram for health guidance, while older patients relied on pharmacy or peer advice. Across all ages, awareness of proper dosing and follow-up was low, highlighting widespread unregulated use. The following core themes are extracted from the codes, and a thick description was developed through repeated review of the interviews. Self-Medication and Peer Advice was a dominant theme, with many patients' using vitamin B12 supplements without consulting a doctor, often based on advice from friends, family, pharmacists, or social media. "I saw a video saying B12 helps with fatigue. I bought it from the pharmacy, no doctor involved." (P15). This trend was especially common among working adults in their 30s and 40s who preferred quick fixes. "My friend was taking B12 injections and felt better, so I started the same." (P03). Over-the-counter availability made this even easier, as patients described vitamin B12 as being as accessible as common painkillers. "B12 ampules and tablets are just kept like Panadol. You say you're feeling low, and they give it."

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(P13). Limited Awareness About Risks and Dosage was widespread; most participants did not understand the potential for overdose or the need for diagnostic testing. "I didn't know you could overdose on vitamins. I thought the more, the better." (P12). Many perceived B12 as a harmless wellness product. Symptom-Driven Consumption was also common, with nonspecific complaints like fatigue and low energy. "I get tired after work, and someone said B12 helps, so I tried it. It made sense to continue." (P05). Trust in Injectables Over Oral Supplements was prominent among users who believed injections were more effective. "Tablets don't work for me... injections give me strength quickly. The doctor also gave them without tests." (P13. Lack of Follow-Up or Monitoring was evident, as most patients reported continuous use without medical evaluations or repeat testing. "I never did any test; I just kept taking it because I felt better. No one told me to stop." (P03). Perception of B12 as an Energy Booster reinforced this unregulated use. Participants described B12 as a remedy for stress and fatigue. "My job is tiring, and someone told me B12 helps with energy. I started taking tablets on my own."(P02).(Figure 2).

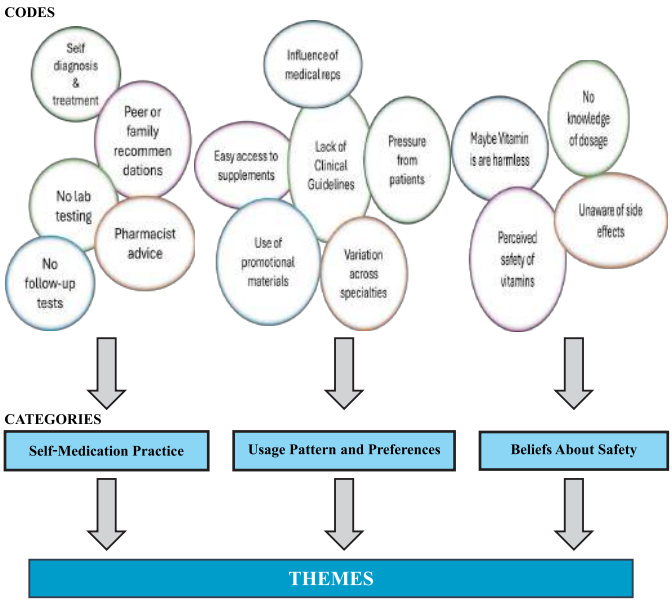

Figure 2: Visual Representation of Coding Tree and Thematic Analysis of Interviews of Doctors

DISCUSSION

This qualitative study provides a nuanced understanding of the perceptions and practices related to the overuse of vitamin B12 supplementation in Lahore, Pakistan. By capturing voices from both healthcare professionals and patients, the study reveals intersecting factors contributing to the widespread, often unmonitored, use of vitamin B12. The findings expose critical gaps in clinical judgment, public awareness, and regulatory oversight, alongside an absence of standardized national guidelines. Physicians across specialties including gynecology, orthopedics, psychiatry, and internal medicine frequently prescribe B12 injections based solely on symptoms such as fatigue, joint pain, numbness, and dizziness, without lab confirmation [16]. This symptom-based approach stems from diagnostic shortcuts and the assumption that B12 is harmless. Many clinicians expressed the belief that B12 poses no risk, reinforcing a culture of routine supplementation without biochemical justification. Another concern is the strong influence of pharmaceutical marketing. Medical representatives provide free samples and persuasive narratives promoting B12 as universally beneficial [17, 18]. These efforts shape prescribing behaviors and blur clinical need with commercial influence. In the absence of standardized protocols, even within the same departments, prescribing patterns rely on personal experience, peer advice, or outdated knowledge, indicating a lack of structured medical education and weak oversight. On the community side, self-medication with B12 is normalized. Many patients use B12 supplements without consultation, relying on peer advice, pharmacists, or social media [19]. Over-the-counter availability in oral and injectable forms worsens this behavior [20]. The findings strongly underscore the need for comprehensive interventions at multiple levels. First, the development and implementation of evidence-based, context-specific national guidelines are essential to standardize the prescription, dosing, and monitoring of vitamin B12 supplementation. These protocols should be disseminated across all levels of healthcare, accompanied by mandatory clinical training to address existing knowledge gaps. Second, regulatory frameworks must be strengthened to monitor pharmaceutical marketing practices, limit unsupervised over-the-counter sales, and ensure ethical standards in supplement promotion. Finally, public health campaigns are needed to improve awareness among patients about the appropriate use of B12, potential risks of overuse, and the importance of medical consultation and testing.

CONCLUSIONS

This study reveals the widespread and unregulated use of vitamin B12 supplements among both healthcare providers and patients in Lahore, shaped by clinical traditions, pharmaceutical marketing, and sociocultural beliefs. Physicians often prescribe B12 based on vague symptoms without diagnostic confirmation, while patients rely on peer influence and media narratives that portray B12 as a harmless health enhancer. These patterns point to critical gaps in clinical training, continuing education, and public health literacy. To ensure safe and rational use of B12 supplements, there is an urgent need for national prescribing guidelines, tighter regulatory oversight, and

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public awareness campaigns rooted in evidence-based practice.

Authors Contribution

Conceptualization: IF
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