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Prevalence and Factors Associated with Tongue Coating Changing Among Dyslipidemia Patients in Chiang Rai, Thailand: A Chinese Medical Practices

Peeranan Pattanamongkol [1], Ning Gu [2]*, Peeradone Srichan [1], Sitthichock Vadphimai [4], Punyawee Khamthai [5]

[1] *Nanjing University of Chinese Medicine, Nanjing, China*
[2] *Nanjing Hospital of Chinese Medicine Affiliated to Nanjing University of Chinese Medicine, Nanjing, China*
[3] *School of Health Science, Mae Fah Luang University, Chiang Rai, Thailand*
[4] *School of Integrative Medicine, Mae Fah Luang University, Chiang Rai, Thailand*
[5] *Department of Traditional Chinese Medicine, School of Public Health, University of Phayao, Thailand*

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***Corresponding author**:
Ning Gu, Nanjing Hospital of Chinese Medicine Affiliated to Nanjing University of Chinese Medicine, Nanjing, China

E-mail:
jsguning@163.com

ABSTRACT

Introduction: Dyslipidemia belongs to the category of 'blood turbidity' in Traditional Chinese medicine. The deficiency and excess of viscera, the ups and downs of qi and blood, the profit and loss of body fluid, the severity of the disease, etc., can be objectively reflected on the tongue coating.

Objective: To investigate the characteristics of tongue coating changes in patients with dyslipidemia.

Method: This study was a cross-sectional study, with data collected from medical records and tongue imaging. All cases come from 266 patients with dyslipidemia who were diagnosed and treated in a total of 2 hospitals in Chiang Rai province, Thailand, namely Somdet Prayannasungworn Hospital and Public Health Service Center, Municipal No.2 (San Nong), from August 1, 2022 to October 31, 2022. This study was approved by the clinical research ethics committee of Chiang Rai Provincial Health Office, Thailand (CRPPHO 52/2565). Data was analyzed by descriptive statistics, including mean, standard deviation, percentages, and chi-square.

Results: A total of 266 individuals were recruited into the analysis; 38.72% were males, 61.28% were females, aged between 30 and 90 years. A large proportion of family history and comorbidities were Hypertension. BMI within 18.5–24.9 (Normal weight) and 25.0-29.9 (Pre-obesity). A large proportion of blood lipids; 40.60% were TC <200 mg/dL, 36.84% were TG<150 mg/dL, 33.83% were LDL-C<100 mg/dL and 49.62% were HDL-C 40-59 mg/dL. In terms of tongue coating, among the 266 patients with dyslipidemia, 132 cases of thin coating accounted for the highest proportion, reaching 49.62%, and other coatings from high to low were greasy coating, thick coating, dry coating, peeled coating, moist coating, slippery coating, and mirror tongue. Total Cholesterol (TC) >200mg/dL was associated with a thin coating (p-value <0.05).

Conclusion: The information from this study can be used to plan health prevention and promotion to improve patients with dyslipidemia and provides an objective basis for the wider application of tongue coating in guiding the traditional Chinese medicine treatment of Thai patients with dyslipidemia in Thailand.

Keywords: Thailand, Traditional Chinese medicine, Dyslipidemia, tongue diagnosis

Introduction

Western medicine shows that blood lipids refer to the general designation of substances such as cholesterol and triglycerides in human blood, and the onset of dyslipidemia is caused by abnormal lipid metabolism. Whether total cholesterol, triglycerides, low-density lipoprotein levels are higher than normal, or high-density lipoprotein cholesterol levels are lower than normal, all are considered to be dyslipidemia. Recently, Aekplakorn et al included 19,021 Thai adults in their study to analyze the epidemiology of dyslipidemia in Thailand and judged dyslipidemia according to the blood lipid levels in the healthy physical examination of the subjects. The results showed that the total cholesterol, LDL-C, triglycerides, and HDL-C were 206.4, 128.7, 131.4, and 46.9 mg/dL, respectively. At the same time, the prevalence of low HDL-C in the Thai population was 47.1%, the prevalence rate of high triglycerides was 38.6%, and the prevalence rate of high LDL-C was 29.6%. The overall survey results showed that among 19,021 Thai adults, the prevalence rate of dyslipidemia was 66.5%, and the prevalence rate in northern Thailand was generally higher [1]. A cross-sectional study by the Medical Research Network of the Consortium of Thai Medical Schools (Medical Research Network of the Consortium of Thai Medical Schools) in 2010-2014 showed that 88.9% of diabetic patients had dyslipidemia [2]. Dyslipidemia is a modern medical term. There is no record of this disease name in Traditional Chinese medicine. In recent years, according to the pathological characteristics of its onset, some Chinese medicine scholars have proposed that dyslipidemia belongs to the category of 'blood turbidity' in Traditional Chinese medicine [3, 4]. In the history of Traditional Chinese medicine, there are concepts about dyslipidemia including vertigo, chest obstruction, phlegm retention, etc. In the article 'Lingshu Wei Qi Disorder', it is said: 'People have fat, grease, and flesh...' In addition to 'flesh', the two parts of fat and grease represent blood lipids to a certain extent; According to the article 'Lingshu Wulong Body Fluid Classification', 'The body fluid of the five grains, which is combined into a grease... tonifying the brain marrow...' According to the above traditional Chinese medicine theory, Traditional Chinese medicine believes that the fat and grease in the human body belong to one of the trace substances, that can provide energy for the development of the human body and daily activities, but the overexpression of the two substances in the human body can cause the occurrence and development of various diseases. During the onset of dyslipidemia, the change in the tongue coating is more obvious [5, 6]. In recent years, the modern application of tongue diagnosis in traditional Chinese medicine has attracted more and more attention from the academic circle. In addition to common clinical tongue diagnosis methods, many tongue diagnosis strategies combined with modern technology have emerged [7]. Ruan Ming and others included 97 patients with malignant tumors and depression in their research included them in the experimental group, and analyzed their tongue coatings with the modern tongue diagnosis technology Four Diagnosis Instrument. The results showed that the grayscale of the tongue coatings in the experimental group was significantly lower in healthy people [5]. Li Hongqin and others included 80 patients with OSAHS in their study and analyzed their tongue coatings using modern tongue diagnosis technology. The results of the study showed that taking tongue color as an example, the disease of spotted tongue was the most serious, and the condition of patients with pale tongue was milder. In terms of tongue coating, patients with thin and white coating are milder, while yellow, thick, and greasy coating is the most serious condition. Most OSAHS patients are obese people, and the key indicator of obese people's tongue coating is yellow and greasy coating. This study is the traditional Chinese medicine classification of OSAHS provides a certain basis [6]. Que Tiesheng, et al [8] analyzed the tongue coatings of nearly 50 malignant tumor patients with the help of the four-diagnosis instrument. The test results showed that compared with normal people, the tongue coating of patients with malignant tumors was obviously darker and yellower. From the perspective of traditional Chinese medicine theory, due to the deficiency of qi and blood in such patients, the system in the body is not running smoothly, and the blood flowing to the tongue is insufficient. Therefore, tongue diagnosis can help us understand the development of the disease in patients with malignant tumors. Limin et al [9] observed the tongue images of patients with neurological deficits in patients with acute cerebral infarction, and the results showed that the more severe the disease, the more stagnant the sublingual collaterals. This also shows that tongue diagnosis has a certain diagnostic effect on such patients, and the research results can provide an important basis for the diagnosis of the severity of the disease. Ran et al [10] conducted a study on 520 patients with chest obstruction and randomly divided them into two groups, one with chest pain symptoms and the other with no chest pain symptoms. The tongue coating, tooth marks, and ecchymosis of each patient were observed with a tongue image acquisition instrument. It was found that the tongue coating area of the patients with chest pain symptoms was significantly more than that of the control group, and there were also significant differences in other indicators between the two groups. Zhao Jing et al [11] used the tongue hyperspectral data to collect 154 outpatient data from the cardiovascular department, and the results showed that there were significant differences in the tongue between hypertensive patients and hypertensive patients with coronary heart disease, indicating that it can be used as a diagnostic basis for disease development. Medical staff can judge the condition by observing and analyzing the patient's tongue image and taking corresponding measures in time.

The deficiency and excess of viscera, the ups and downs of qi and blood, the profit and loss of body fluid, the severity of the disease, the depth of the disease location, etc., can be objectively reflected on the tongue coating. From a clinical point of view, this study conducted a preliminary analysis of the prevalence of dyslipidemia patients and tongue coating changes in 266 Thai patients with dyslipidemia.

Methodology

A cross-sectional study was applied, with data collected from medical records and tongue imaging, aged 18 years or older. All cases come from 266 Thai patients with dyslipidemia who were diagnosed and treated at Somdet Prayannasungworn Hospital and Public Health Service Center, Municipal No.2 (San Nong), Chiang Rai Province, Thailand from August 1, 2022 to October 31, 2022. This study was approved by the clinical research ethics committee of Chiang Rai Provincial Health Office in Thailand (CRPPHO 52/2565).

The inclusion criteria are: (1) Have been diagnosed with dyslipidemia; (2) age ≥18 years; gender is not limited; (3) Four blood lipids (TG, TC, LDL-C, HDL-C); (4) traditional Chinese medicine (TCM) tongue diagnosis; (5) Informed consent, willing to participate. The exclusion criteria are (1) Those under the age of 18; (2) Incomplete blood lipid testing and TCM tongue diagnosis; (3) Pregnant and lactating women; (4) Patients with infectious diseases and mental illness.

Data collection: sex, age, nationality, blood group, family history, comorbidities, weight, height, BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL-C) and high-density lipoprotein (HDL-C) of the patients were detected. The patient's tongue coating was taken and recorded after the patient agreed.

Data processing and analysis: After the collection of data, these were edited. All the collected data were summarized and scrutinized carefully and then recorded. Finally, relevant tables were prepared by the objectives of the study. Data is presented mostly in tabular form because it is simple in calculation, widely used, and easy to understand. Microsoft Excel program and IBM-SPSS Statistics program (Version 20, IBM Corp.) were used for data analysis, including mean, standard deviation, percentages, and chi-square.

Results

A total of 266 individuals were recruited into the analysis; there were 103 males and 163 females; aged 30-90 years, with an average age of (62.27±9.63) years. A large proportion of family history and comorbidities were hypertension. BMI within 18.5–24.9 (Normal weight) and 25.0–29.9 (Pre-obesity). A large proportion of blood lipids; 40.60% were TC <200 mg/dL, 36.84% were TG<150 mg/dL, 33.83% were LDL-C<100 mg/dL and 49.62% were HDL-C 40-59 mg/dL (Table 1).

Table 1 General characteristics of patients with dyslipidemia

Characteristic	n	%
Total	266	100.0
Sex		
Male	103	38.72
Female	163	61.28
Age (years)		
30-39	4	1.50
40–49	19	7.14
50-59	76	28.57
60-69	110	41.35
70-79	48	18.05
80-89	8	3.01
≥ 90	1	0.38
Mean = 62.27 years, SD = 9.63, Min = 35, Max = 90		
Nationality		
Thai	266	100.0
Blood group		
A	52	19.55
B	66	24.81
O	135	50.75
AB	13	4.89
Family history of an illness		
Hypertension	99	37.22
Diabetes mellitus	68	25.56
Chronic kidney disease	3	1.13
COPD	2	0.75
Gout	2	0.75
Asthma	1	0.38
Throat cancer	1	0.38
Depressive disorder	1	0.38
Heart disease	1	0.38
Comorbidities		
Hypertension	225	84.59
Diabetes mellitus	145	54.51
Chronic kidney disease	82	30.83
Asthma	19	7.14
COPD	11	4.14
Coronary Artery Disease	11	4.14
Depressive disorder	6	2.26
Thyrotoxicosis	4	1.50
Epilepsy	3	1.13
Colon cancer	2	0.75
Atrial fibrillation	2	0.75
Generalized anxiety disorder	1	0.38
Rheumatoid	1	0.38
Tuberculosis	1	0.38
Post-traumatic stress disorder	1	0.38
Gout	1	0.38
Stroke	1	0.38

Characteristic	n	%
Weight (kg)		
40-49.9	35	13.16
50-59.9	73	27.44
60-69.9	93	34.96
70-79.9	36	13.53
80-89.9	19	7.14
90-99.9	8	3.01
≥ 100	2	0.75
Height (cm)		
130-139.9	6	2.26
140-149.9	49	18.42
150-159.9	116	43.61
160-169.9	74	27.82
170-179.9	20	7.52
≥180	1	0.38
BMI		
< 18.5 (Underweight)	8	3.01
18.5–24.9 (Normal weight)	110	41.35
25.0–29.9 (Pre-obesity)	110	41.35
30.0–34.9 (Obesity class I)	32	12.03
35.0–39.9 (Obesity class II)	4	1.50
≥ 40 (Obesity class III)	2	0.75
Systolic blood pressure (mmHg)		
< 120 (Optimal)	33	12.41
120-129 (Normal)	36	13.53
130-139 (High normal)	81	30.45
140-159 (Hypertension Level 1)	100	37.59
160-179 (Hypertension Level 2)	16	6.02
≥ 180 (Hypertension Level 3)	-	-
≥ 140 (Isolated systolic hypertension (ISH))	116	43.60
Diastolic blood pressure (mmHg)		
< 80	182	68.42
80-84	32	12.03
85-89	23	8.65
90-99	24	9.02
100-109	3	1.13
≥ 110	2	0.75
Isolated systolic hypertension (ISH) < 90	237	89.09
Total Cholesterol (mg/dL)		
< 200 (Desirable)	108	40.60
200-239 (Borderline high)	103	38.72
≥ 240 (High)	55	20.68
Triglyceride (mg/dL)		
< 150 (Normal triglycerides)	98	36.84
150-199 (Borderline-high triglycerides)	82	30.83
200-499 (High triglycerides)	83	31.20
≥ 500 (Very high triglycerides)	3	1.13
LDL-C (mg/dL)		
< 100 (Optimal)	90	33.83
100-129 (Near optimal/above optimal)	76	28.57
130-159 (Borderline high)	60	22.56
160-189 (High)	25	9.40
≥ 190 (Very high)	15	5.64
HDL-C (mg/dL)		
<40 (Low)	35	13.16
40-59	132	49.62
≥ 60 (High)	99	37.22

Prevalence of dyslipidemia patients found that classified by type of blood lipid; the highest percentage was abnormal triglyceride (63.16%), followed by abnormal total cholesterol (59.40%), abnormal LDL-C (37.60%), and abnormal HDL-C (13.16%) (Table 2).

Table 2 The differences in blood lipids among patients with dyslipidemia (n=266)

Blood lipid	n	%
Abnormal Total Cholesterol (> 200 mg/dL)		
Abnormal	158	59.40
Normal	108	40.60
Abnormal Triglyceride (> 150 mg/dL)		
Abnormal	168	63.16
Normal	98	36.84
Abnormal LDL-C (> 130 mg/dL)		
Abnormal	100	37.60
Normal	166	62.40
Abnormal HDL-C (< 40 mg/dL)		
Abnormal	35	13.16
Normal	231	86.84

In terms of tongue coating, among the 266 Thai patients with dyslipidemia, 132 cases of thin coating accounted for the highest proportion, reaching 49.62%. Other coatings from high to low were greasy coating, thick coating, dry coating, peeled coating, moist coating, slippery coating, and mirror tongue, accounting for 28.20%, 6.77%, 6.39%, 4.14%, 2.26%, 1.88%, and 0.75%, respectively (Table 3).

Table 3 The differences of tongue coating by patients with dyslipidemia

Tongue coating	n	%
Thin coating	132	49.62
Greasy coating	75	28.20
Thick coating	18	6.77
Dry coating	17	6.39
Peeled coating	11	4.14
Moist coating	6	2.26
Slippery coating	5	1.88
Mirror tongue	2	0.75

This study found that abnormal total cholesterol was associated with thin coating statistically significantly (p-value <0.05). Patients with abnormal total cholesterol had a more thinner coating than patients with normal total cholesterol, 65.91%, and 34.09%, respectively (Table 4).

Table 4 The associated of abnormal total cholesterol and thin coating by patients with dyslipidemia

Total Cholesterol	Thin coating n (%)	No Thin coating n (%)	X^2	p-value
Abnormal Total Cholesterol	87 (65.91)	71 (52.99)	4.60	0.032*
Normal Total Cholesterol	45 (34.09)	63 (47.01)		

* Significant level at α=0.05

Discussion

Dyslipidemia refers to a class of diseases mainly manifested by abnormal serum lipid metabolism. It is one of the important risk factors for various cardiovascular and cerebrovascular diseases such as heart disease and ischemic stroke. Traditional Chinese medicine refers to dyslipidemia as ointment fat, which is believed to be caused by insufficient innate endowment, improper diet, old age, weakness, and emotional disorders. The pathogenesis is weakness of the spleen, stomach, kidney yang, and abnormal distribution of water and grain essence and body fluids, leading to phlegm turbidity and endogenous dampness.

Observation is the first of the four diagnostic methods in traditional Chinese medicine. As an important component of observation in traditional Chinese medicine, tongue diagnosis has extremely important significance and value in determining the rise and fall of positive qi, the nature of pathogenic diseases, the depth of disease location, and predicting the prognosis and prognosis of diseases in clinical practice. The theory of traditional Chinese medicine points out that the tongue, as an important organ of the human body, can reflect the operation of internal organs to a certain extent. Therefore, traditional Chinese medicine can understand the condition of the body by observing the changes in the tongue. Once there is a problem with an organ in the body, it will affect the blood flow to the tongue and eventually lead to corresponding changes in the tongue. The tongue is not only an important organ of the human body but also reflects the development of certain diseases [12]. With the rapid development of modern medicine, new technologies such as artificial intelligence and big data analysis can provide strong support for us to optimize tongue diagnosis. With the support of the above technologies, the characteristics of tongue diagnosis can be further refined, thus laying a solid foundation for clinical diagnosis [13]. Clinically, the common changes in traditional Chinese medicine tongue coating include thin coating, greasy coating, thick coating, dry coating, peeled coating, moist coating, slippery coating, and mirror tongue. Tongue coating refers to a layer of coating spread on the tongue surface, which fumigates the stomach qi upwards from the stomach qi. Food turbidity is formed by condensing on the tongue surface.

In this study, a total of 266 patients with dyslipidemia in Thailand were included. In terms of tongue coating distribution, 132 cases with thin coating accounted for the highest proportion, and other coatings from high to low were greasy coating, thick coating, dry coating, peeled coating, moist coating, slippery coating, and mirror tongue. Total Cholesterol (TC) >200mg/dL was associated with a thin coating (p-value <0.05).

In terms of thin coating, it is mainly divided into two directions: If it is in a state of health, suggesting that the stomach has qi for growth and development. If it is in a state of illness, it means that the condition is mild and the stomach qi is not injured. In conclusion, the distribution of tongue coating in patients with dyslipidemia in Thailand is mainly thin coating, which means that the condition is mild and patients with abnormal total cholesterol had more thin coating than patients with normal total cholesterol. However, tongue diagnosis mainly relies on the naked eye recognition of traditional Chinese medicine doctors under natural light, which can largely guide clinical diagnosis and treatment. At present, due to the lack of a unified standard for tongue diagnosis in traditional Chinese medicine, most research has focused on a certain disease, indicator, or technology. Due to the different instruments, methods, and technologies used and the inability to consider multiple aspects, there may be bias in the data and some limitations. Therefore, the path of objectification, informatization, and scientific sound of traditional Chinese medicine tongue diagnosis is still long, and researchers need to continuously research and explore to promote the development of objectification of tongue diagnosis and the process of scientific sound of traditional Chinese medicine.

Conclusion

The information from this study can be used to plan health prevention and promotion to improve patients with dyslipidemia in Chiang Rai, Thailand. In traditional Chinese medicine clinical treatment based on syndrome differentiation, accurate diagnosis needs to grasp the changing regularity of tongue coating and distinguish its commonness and individuality. This study provides an objective basis for the wider application of tongue coating in guiding the traditional Chinese medicine treatment of Thai patients with dyslipidemia in Thailand.

Recommendations

The current study can be interpreted as a first step in the research on tongue coating changes among dyslipidemia patients in Chiang Rai, Thailand in Chinese medical practices. The number of cases observed in this paper is small, there is still a need for future research to expand the sample size and extend the research in the future.

Competing interests

The authors had no competing interests to declare.

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References

[1] Aekplakorn W, Taneepanichskul S, Kessomboon P, Chongsuvivatwong V, Putwatana P, Sritara P, et al. Prevalence of Dyslipidemia and Management in the Thai Population, National Health Examination Survey IV, 2009. Journal of Lipids. 2014; 2014:249584.

[2] Narindrarangkura P, Bosl W, Rangsin R, Hatthachote P. Prevalence of dyslipidemia associated with complications in diabetic patients: a nationwide study in Thailand. Lipids in Health and Disease. 2019;18(1):90.

[3] Zhu JJ, Wang SF. Overview of TCM research on dyslipidemia. TCM Res. 2022;35(01):83-7. (祝晶晶, 王守富. 血脂异常的中医药研究概述. 中医研究. 2022;35(01):83-7.)

[4] Li X, Zhang R, Zhang Z, Wang JW, Yin XW, Zhou T, et al. Theory of Spleen and Stomach and Blood Turbidity. Tianjin Journal of Traditional Chinese Medicine. 2021;38(08):953-7. (李雪, 张茹, 张妍, 王嘉伟, 殷秀雯, 周滔, et al. 脾胃与血浊理论. 天津中医药. 2021;38(08):953-7.)

[5] Ruan M, Chen JX, Shen XH, Lv LL, Zheng L, Zhu WR, et al. Observation and Objective Analysis of Facial Expressions and Tongue Images in Malignant Patients with Depression and Anxiety. Journal of liaoning university of tcm. 2019;21(07):140-3. (阮铭, 陈敬贤, 沈小珩, 吕玲玲, 郑岚, 朱伟嵘, et al. 恶性肿瘤伴抑郁焦虑患者中医面色、舌象观察及客观化分析. 辽宁中医药大学学报. 2019;21(07):140-3.)

[6] Li HQ, Jin MY, Cao LM, Wang JL, Wang KX, Chai XP, et al. Study on the correlation between tongue picture and sleep rhythm in patients with obstructive sleep apnea syndrome. Zhejiang JITCWM. 2018;28(08):672-5. (李红琴, 金满意, 曹利民, 王建龙, 王克先, 柴晓萍, et al. 阻塞性睡眠呼吸暂停综合征患者舌象与睡眠节律相关性研究. 浙江中西医结合杂志. 2018;28(08):672-5.)

[7] Gu JY, Wang XJ, Qu H, Zhang XX, Zhang R, Ni T, et al. Overview of Modernization of Tongue Diagnosis in Traditional Chinese Medicine. International Journal of Traditional Chinese Medicine. 2022;44(9):1077-81. (顾继昱, 王旭杰, 曲华, 张雪雪, 张蕊, 倪恬, et al. 中医舌诊现代化研究发展概况. 国际中医中药杂志. 2022;44(9):1077-81.)

[8] Que TS, Lv JY, Huang LP, Lan D, Li JQ. Relationship between TNM staging and apoptosis of tongue coating cells in patients with malignant tumors. Liaoning Journal of Traditional Chinese Medicine. 2010;37(01):92-3. (阙铁生, 吕军影, 黄李平, 蓝东, 李佳荃. 恶性肿瘤患者 TNM 分期与舌苔细胞凋亡的关系研究. 辽宁中医杂志. 2010;37(01):92-3.)

[9] Cao LM, Li HQ, Wang JN, Zhong Y. Analysis of the correlation between the degree of neurological impairment, the degree of sublingual collateral stasis, and the pH value of the tongue surface in patients with acute cerebral infarction. Zhejiang JITCWM. 2016;26(10):913-5. (曹利民, 李红琴, 王竞男, 钟远. 急性脑梗死患者神经功能缺损程度与舌下络脉瘀滞程度及舌面 pH 值相关性分析. 浙江中西医结合杂志. 2016;26(10):913-5.)

[10] Ding R, Lu XZ. Objective Study of TCM on Chest Pain and Tongue Based on Classification of Chest Pain. Acta Chinese Medicine and Pharmacology. 2017;45(06):13-6. (丁然, 陆小左. 基于有无胸痛分型的胸痹舌象中医客观化研究. 中医药学报. 2017;45(06):13-6.)

[11] Zhao J, Ma B, Liu M, Liu ZZ, LI G, Li Z, et al. Screening Method for Coronary Heart Disease in Patients with Tongue Hyperspectral Hypertension. Spectroscopy and Spectral Analysis. 2022;42(2):512-6. (赵静, 马贝, 刘明, 刘珍珍, 李刚, 李哲, et al. 舌体高光谱的高血压患者中合并冠心病的筛查方法. 光谱学与光谱分析. 2022;42(2):512-6.)

[12] Tian Q, Lu Q, Ren J, Wang M, Zhang Y, Shang QX. Research Progress on Characteristics and Objectification of Tongue Image in Hypertension. Journal of Basic Chinese Medicine. 2023(01):160-3. (田琪, 吕琴, 任健, 王敏, 张硕, 商庆新. 高血压病舌象特征及其客观化研究. 中国中医基础医学杂志. 2023(01):160-3.)

[13] Lu XB, Ma KW, Wang YQ, Hao YM. Study on the Characteristics of Emotional "Joy" Tongue Color Based on the Objectification of Tongue Diagnosis. World Science and Technology/Modernization of Traditional Chinese Medicine and Materia Medica. 2019;21(03):471-6. (鲁晓篝, 马凯雯, 王忆勤, 郝一鸣. 基于舌诊客观化的情志“喜”舌色特征研究. 世界科学技术-中医药现代化. 2019;21(03):471-6.)

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Factors associated with sanitation practices preventing diarrhea at household-level in Mogadishu, Somalia

Abdirizak Mohamud Yusuf [1], Yanasinee Suma [2], Nittaya Pasukphun [1]*

[1]*Faculty of Public Health, Thammasat University (Rangsit campus), Pathumthani, Thailand*

[2] *Faculty of Public Health, Thammasat University (Lampang campus), Lampang, Thailand*

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***Corresponding author**:
Nittaya Pasukphun, Faculty of Public Health, Thammasat University (Rangsit campus), Pathumthani, Thailand

E-mail:
nittapsp@gmail.com

ABSTRACT

Introduction: Poor sanitation is responsible for the mortality and morbidity related to diphtheria worldwide, particularly under-five years children. The World Health Organization (WHO) estimated that 2.39 billion children under five had diarrhea. Diarrhea is one of the major causes of all child deaths from water contamination, improper sanitation, or hygienic practices. This study aimed to investigate factors associated with diarrhea in homes with children under five years old in Hodan District, Mogadishu, Somalia.

Methods: A cross-sectional study was conducted in the Hodan district of Mogadishu, Somalia, from December 2021 to February 2022. The study participants were randomly selected from 241 households. Descriptive statistics were processed, and logistic regression analysis was used to detect factors associated with diarrhea that related to sanitation practice at a significant level of $\alpha = 0.05$.

Results: More than 60.6% of the participants lived in multi-family homes, and 81.3% of households lacked access to handwashing facilities. Among 29% of households had poor sanitation conditions. Residences with multi-family homes was associated with diarrhea in children under five years (p-value= 0.004), followed by families whose inhabitants in IDP areas were statistically significant (p-value= 0.001). Family income had a nearly increased risk of diarrhea occurrence in children (p-value =0.001). The households with dependent pit latrines without slabs had (p-value= 0.011). Participants who did not use drinking water treatment were their children highly associated with developing diarrhea compared to those who treated their drinking water at home (p-value=0.003). Families who did not adequately cover their food during preparation had correlated diarrhea in their children compared to those who maintained safe food handling (p-value=0.029).

Conclusion: Providing adequate water, hygiene, and sanitation services in the Hodan district is vital for diarrheal prevention. Awareness-raising at a household level improved sanitation facility, and sanitation practices and encouragement should be scaled up accordingly. Further in-depth studies related to the WASH services gap should also be conducted.

Keywords: Diarrhea, Hygiene, Household, Sanitation Practices, Water

Introduction

Poor sanitation is responsible for 4% of mortalities and 5.7% of morbidity worldwide, particularly among under-five children [1]. Children under five experience 2.5 billion cases of diarrhea each year, and estimates indicate that overall incidence has remained largely stable over the last two decades [2]. A lack of safe drinking water, inadequate sanitation, poor hygiene, and overcrowding continue to be major contributors to diarrhea in children in low- and middle-income countries [3]. These diarrheal infection determinants are related to poverty and sanitation aspects [4]. According to comparable research, more than 94% of diarrhea episodes can be prevented by improving sanitation and promoting hygiene [5]. However, poor sanitation practices are also responsible for diseases such as trachoma and parasitic intestinal

infections that contribute to an additional burden of diseases, affecting public health [6].

Indeed, 90% of diarrhea-related deaths occur in South Asia and Sub-Saharan African countries including Somalia. More than half of all diarrhea deaths in children under five years old occur in just 15 African and Asian nations. Somalia is one of many African countries with high diarrhea rates. On the other hand, unexpectedly, a different study revealed that child mortality in sub-Saharan Africa is 15 times higher compared to the developed world, [7]. On the other hand, in a healthy child, a single incidence of diarrhea is typically self-limiting and has no long-term sequels. Besides, several episodes per year can lead to nutritional deficits and long-term consequences, [8]. Sanitation is the maintenance of sanitary conditions through safe feces disposal, and wastewater disposal to separate human excreta from human touch at all sanitation facilities sequence, and wastewater disposal [9].

The risks associated with poor household sanitation practices predominantly affect vulnerable people suffering from diarrhea caused by polluted water sources. Due to insufficient water storage containers, shortage of latrines, living in a house with few rooms, and not exclusively breastfeeding for the first six months of life, diarrhea remained a significant public health issue for under-five children in Somalia [4]. Increased demand for inadequate systems and services puts cities in danger of large-scale illness outbreaks linked to poor sanitation, since, there have been few long-term interventions in this sector, and the ability for new changes is limited, due to limited resources [10]. The availability of latrines, household sanitation facilities, water handling, type of water supply, and infant feces disposal were all factors that contributed to the risk of acute childhood diarrhea. This result can potentially increase the frequency of diarrheal disease in Mogadishu, particularly in informal settlement sites [11].

The second-leading cause of death in children under five years is diarrheal disease. However, approximately 525,000 children under five die from diarrhea each year [12]. In Mogadishu, Somalia, inadequate sanitation services at the households cause the reoccurrence of acute watery diarrhea in under-five children [12]. A significant portion of diarrheal disease can be avoided through safe drinking water, adequate sanitation, and good hygiene [13]. However, a few studies in the Hodan district, Mogadishu, Somalia research site highlighted the importance of residential sanitation practices concerning diarrhea incidence resulting in infections triggered by water caused by poor hygiene, sanitation, and overpopulation, [13]. Therefore, this study aimed to determine the factors associated with diarrhea related to sanitation practices in homes with children under five years in Hodan District, Mogadishu, Somalia.

Methodology

Study design

A cross-sectional study design was utilized. The study population involved all households with children aged less than five years. This research takes place in the Hodan district of Mogadishu, Somalia, between 15th December 2021 and 28th February 2022.

Study samples

Kish Leslie's (1965) formula for cross-sectional studies was calculated using sample size calculation with a level of confidence of 1.96, a margin of error of 0.05, and a baseline indicator level was = 0.17 [14]. The number of households was 3,210 households. The calculated sample size was 217 respondents. With 10% added to the response rate, a final total of 241 respondents were collected in case of incomplete data from the required quota. These households are based on the estimated population proportion size from the district plan. A systematic sampling technique was used to select households in the Hodan district, including the internally displaced people (IDP) section, particularly homes with under five children who have lived in the study site, for more than five years. Participants who met the inclusion criteria were interviewed to obtain information about socio-demographic characteristics, access sanitation factors, and risk factors of diarrhea among households having under five years children. The main household informants were mothers or caretakers for selected children under five years.

The trained enumerators then were approached and explained the purpose of the study to the selected caregivers; allowing them to ask questions on areas that were not clear to ensure that they understood the purpose and the procedure to be followed before signing a consent form concurrence were recruited into the study. Each household was selected as one caregiver.

Inclusion and exclusion criteria

The study included households with children under five years old who lived in the Hodan district for at least five years. All households without children under five were excluded from the study. The assessment also eliminated persons who had only lived in the Hodan district for less than five years and children whose families did not consent to be part of the study.

Validity and reliability

The researcher recruited four enumerators experienced in human research ethics. Then, instruments were pre-tested for an interview before data collection to check the appropriateness of the questionnaires. Some amendment was made after the pre-test. Data were gathered using the interview techniques with an observation checklist. In selected households, trained data collectors interviewed each

respondent. A structured questionnaire was developed to gather data on families with children under five years old at the study site. The questionnaire is divided into two sections; The first part; assesses the socio-demographics of households, comprising age, gender, marital status, education, occupation, and home ownership. Section two comprises aspects of the collection of household predictor variables for diarrhea in the Hodan district, Mogadishu, Somalia. However, the dependent variable for the study was diarrhea under five years.

Data analysis

SPSS version 26 was used to enter, code, clean, and analyze the data. Accordingly, the descriptive level was analyzed and presented using tables, frequencies, and percentages. Binary and logistic regressions were used to assess the association of various sanitation factors of childhood diarrhea using an unadjusted odds ratio and adjusted odds ratio with a corresponding 95% confidence interval, to determine any statistically significant relationship between sanitation practices and diarrhea. A p-value of less than 0.05 was considered statistically significant.

Ethical considerations

The Ministry of Health and Human Services Ethical and Research Committee approved the study in Somalia with reference no. MOH&HS/DGO/1947/ DEC/2021. The Hodan District Commissionaire also permission was obtained. Informed written consent was obtained from all respondents before interviewing and house-to-house observation.

Results

Socio-demographic characteristics of the study participants

In this study, 241 participants were interviewed. Of these, 80.9% were female. The majority of participants were between the age of 26-35 (46.1%) and the age of 36-45 (23.7%). The majority of participants were illiterate (44.0%), 70.1% were unemployed, and 37.3% had approximately 200 dollars.

Majority (60.6%) of respondents were residents of multi-family homes, and the number of family members per household varied as most of them lived in a home of 5-10 persons (58.1%). Most participants lived in rental houses (51.9%), as 24% lived in government-owned houses. All of the study households had available toilet facilities. Children experienced diarrhea in the last two weeks were under 35 months, and the majority believed diarrhea was a health risk.

Table 1 Socio-demographic characteristics of the study participants (n=241)

Characteristics	n	%
Gender		
Male	46	19.1
Female	195	80.9
Age (mothers)		
18-25	37	15.4
26-35	111	46.1
36-45	57	23.7
46-55	23	9.5
56-65	13	5.4
Educational status		
Primary	53	22.0
Secondary	74	30.7
University	8	3.3
Illiterate	106	44.0
Marital status		
Married	199	82.6
Unmarried (single, widowed, divorced)	42	17.4
Occupational status		
Employed	72	29.9
Unemployed	169	70.1
Family income per month		
Less than $ 100 US	62	25.7
Between $ 100 to 200 US	89	36.9
More than $ 200 US	90	37.3
Kind of house		
Single-family homes	88	36.5
Multi-family homes	146	60.6
Apartments	7	2.9
Family members (persons)		
1-5	49	20.3
5-10	140	58.1
Over 10	52	21.6
House ownership		
Owner	58	24.1
Rented from private	125	51.9
Government home	58	24.1
Number of under five years old (persons)		
≤ 3	103	42.7
≥ 4 children	138	57.3
Child experienced diarrhea		
Yes	74	30.7
No	167	69.3
If yes what was child (months)		
0 - 11	18	7.5
12 - 23	47	19.5
24 - 35	9	3.7

WASH risk factors of diarrhea among households having under five years children

The water, sanitation, and hygiene risk factors where around 32.4% of the households practiced pit latrines without slabs, whereas 32.0% had squat toilets with water flush latrines, but 71.4% of the respondents used clean restrooms, and 28.6% used unclean baths. 40.7% refused to practice the garbage disposal methods, and 24.1% reported they discarded in an open area. 71.0% had good household sanitation conditions, and 98.8% had used pipe water supply regarding the water sources. 53.5% used buckets with a lid for water storage at the household level, whereas 7.5% had Jerri cans. Almost 45.2% of participants practiced chlorination for water treatment, while only 4.6% used filtration (Table 2).

Table 2 WASH risk factors of diarrhea among households having under five years children

Characteristics	n	%
Type of latrine		
Sit-down toilet with water flush	47	19.5
Squat toilet with water flush	77	32.0
Pit latrine without slab/open pit	78	32.4
Dry toilet	39	16.1
Cleanliness of the latrine		
Clean	172	71.4
Unclean	69	28.6
Garbage disposal		
Refuse disposal method	98	40.7
Disposed into open pit	85	35.3
Discarded in open area	58	24.1
Household sanitation condition		
Good	171	71.0
Poor	70	29.0
Source of water		
Pipe	238	98.8
Borehole	3	1.2
Water storage at household		
Bucket with a lid	129	53.5
Bucket without a lid	38	15.8
Jerry cans	18	7.5
Water treatment		
Boiling	26	10.8
Chlorination	109	45.2
Filtration	11	4.6
I don't use any method	68	28.2
Others	26	10.8
Using soap		
Yes	223	92.5
No	18	7.5
Hygiene status among children		
Good	168	69.7
Poor	73	30.3
Food preparation		
Fair	150	62.2
Good	91	37.8

Association between socio-demographic and access sanitation facilities at household-level

Being unmarried and low family income increases the risk of diarrhea in children (p-value=0.004). Meanwhile, families earning $200 or more were nearly 29 times more likely to get diarrhea from their children (p-value=0.001). With regards to children's diarrhea is attributed to living in government-owned buildings due to old and inadequate sanitation facilities. Multi-family apartments. The neighboring section in October had 16 odds more than their counterparts (p-value was 0.003).

Table 3 Association between socio-demographic and access sanitation facilities at household-level

Factors	OR	95%CI	AOR	95%CI
Gender				
Male	1.00		1.00	
Female	0.86	0.426-1.76	0.71	0.31-1.66
Age of mother/ caretaker years				
18-25	1.00		1.00	
26-35	1.57	0.71-3.43	1.28	0.56-2.95
36-45	1.87	0.76-4.58	1.46	0.56-3.77
46-55	1.14	0.38-3.37	1.01	0.30-3.37
56-65	0.52	0.15-1.87	0.40	0.09-1.70
Marital Status				
Married	1.00		1.00	
Unmarried	0.36	0.18-0.72	0.41	0.20-0.86
Education				
University	1.00		1.00	
Secondary	0.22	0.02-1.89	0.16	0.01-1.64
Primary	0.93	0.10-8.82	0.69	0.06-7.74
Illiterate	0.26	0.00-2.24	0.24	0.04-0.38
Family income				
Less than $ 100	1.00		1.00	
Between $ 100-200	7.01	3.39-14.48	0.12	0.04-0.38
More than $ 200	28.98	11.24-74.68	0.47	0.17-1.30
House ownership				
Owner	1.00		1.00	
Rented from private	1.83	0.89-3.79	2.81	1.05-7.54
Government home	0.29	0.13-0.63	3.83	1.53-9.57

Factors	OR	95%CI	AOR	95%CI
Area of residence				
Zona-K IDP area	1.00		1.00	
Kacan	6.66	2.33-19.02	0.03	0.01-0.12
Ahmed Gurey	6.38	1.74-23.37	6.38	1.74-23.37
Horseed	0.17	0.06-0.45	0.17	0.06-0.45
October	17.94	4.82-59.51	16.94	4.82-59.51
Kind of house				
Single-family homes	1.00		1.00	
Multi-family homes	0.03	0.01-0.02	0.00	0.00-0.00
Apartments	0.57	0.00-0.01	0.00	0.00-0.00
Number of family members				
1-5 persons	1.00		1.00	
5-10 persons	0.46	0.21-1.00	0.68	0.24-1.89
Over 10 persons	0.69	0.27-1.75	1.08	0.32-3.61
Occupational status				
Employed	1.00		1.00	
Unemployed	0.67	0.36-1.25	0.68	0.36-1.28
Number of under five years				
Less than 3 children	1.00		1.00	
More than 4 children	1.30	0.12-2.14	1.31	0.65-2.63

*Significant level at α=0.05

Association between WASH risk factors in diarrhea in households in children

The type of latrine that was found to be associated with childhood diarrhea, particularly in families who practice pit latrines without slabs (p-value= 0.001). The households who do not utilize any water treatment were 11.40 times which are more likely to have diarrhea in their children (Table 4).

Diarrhea was statistically associated with low attendance of children who are playing in open spaces in the IDPs and host communities (p-value=0.002). Similarly, families who do not practice well their food preparation in terms of food safety and covering immediately after cooking had odds of 14.65 (95% CI=0.5.62-38.15) more likely to develop diarrhea compared to those families adequately prepared food and protected any environmental risks at home. The type of latrine, water treatment, children's hygiene levels, and food handling were found to be associated with diarrhea in children.

Table 4. Association between WASH risk factors in diarrhea with children at households

Factors	OR	95%CI	AOR	95%CI
Type of latrine				
Toilet with water flush	1.00		1.00	
Toilet with water flush	0.44	0.16-1.21	6.56	2.16-186.65
Pit latrine without slab	0.13	0.05-0.36	4.39	2.37-37.11
Dry toilet	0.48	0.15-1.51	2.32	0.66-8.12
Cleanliness of the latrine				
Clean	1.00		1.00	
Unclean	1.12	0.60-2.06	1.15	0.70-3.22
Household sanitation condition				
Good	1.00		1.00	
Poor	1.73	0.91-3.29	0.78	0.36-1.68
The main source of water supply				
Pipe	1.00		1.00	
Borehole	0.88	0.07-9.91	3.31	0.03-281.71
Drinking water treatment				
Boiling	1.00		1.00	
Chlorination	4.87	0.18 -8.11	5.69	2.53-119.30
Filtration	11.00	0.17-70.67	57.98	4.30-781.26
I don't use any method	11.40	1.77-11.21	8.99	2.47-153.61
Do you use soap				
Yes	1.00		1.00	
No	2.33	0.65-8.32	1.20	0.21-6.70
Hygiene status among children				
Good	1.00		1.00	Ref
Poor	2.09	1.09-4.01	3.91	1.80-8.48
Food preparation				
Fair	1.00		1.00	
Poor	14.65	0.56-38.15	20.71	7.73-55.48
Caregiver wash hands with soap				
Yes	1.00		1.00	
No	1.77	0.20-1.57	0.95	0.22-3.96

Factors	OR	95%CI	AOR	95%CI
Type of sanitation facility				
Ecosan toilet	1.00		1.00	
Pit latrine with a slab	0.34	0.16-1.71	0.32	0.15-0.70
Pit latrine without a slap	1.56	0.61-3.97	1.58	0.62-4.05
VIP-latrine	4.85	0.02-9.12	4.57	0.01-7.74

*Significant level at α=0.05

Discussion

The study found that 29% of the households had poor sanitation status, associated with diarrhea in children under five years old. The majority of participants resided in an overcrowded neighborhood with IDPs families, making them more prone to parasites in diarrheal diseases. This shows that those who are residents of IDPs would have a high risk of having diarrhea with their children compared to those who are living in domestic households. This aligns with earlier research reported by [15]. Both IDPs and host communities in the study site had poor sanitation practices and unclean sanitation facilities. Diarrhea was 73 times more likely to occur in children living in households that did not consider it a health risk.

Although this study was conducted in Mogadishu it is presented, that disposal of waste, household water handling, water source, handwashing behaviors, and improper infant feces disposal were risk factors for sanitation practices in Somalia. Adults from IDPs sometimes practiced open defecation, as reported by [11].

The study also found that 84.2% of homes had private latrines whereas 15.8% had public latrines. The status of IDPs is characterized by high population density, poor sanitation facilities, shortage of water supply, inadequate sanitation and hygiene services, and insufficient health awareness campaigns owing to the emergency, [13]. A study conducted in Ethiopia revealed a disparity in the use of communal and privately-owned toilets, allowing the assessment of improved and unimproved sanitation facilities [16].

In this study, 71.4% of respondents used clean restrooms, whereas 28.6 percent utilized dirty latrines, this is a high risk of diarrhea outbreaks. However, another study found that proper sanitation facilities such as clean latrines are key preventive approaches for diarrheal infections, and superior for reducing fecal-oral transmission, [15]. This study shows that households without toilets had a statistically significant difference in diarrhea, compared to those with latrines. According to a recent survey in North Ethiopia, 94% know the importance of latrines for health, however, 48.3% believe latrines are primarily for the wealthy people [5].

This study revealed that the families who did not clean their latrines were more likely to have diarrhea than those who clean their toilets regularly. We observed sanitation facilities in each household to determine the sanitation status at the household level and 87.6% of households saw flies in the food preparation area, followed by 81.5% of households lacking access to handwashing facilities. Approximately, 83.4% cleaned their kitchen, swept, and tidied to avoid food contamination. This result is also lower than the findings of a similar study that presented 92% households cleaned their kitchen and swept, in Kersa Woreda, Eastern Ethiopia [17].

Moreover, 66.8% of respondents prioritized waste around their homes, but only 33.2% had adequately managed it. Comparing this study's findings to those from South Ethiopia, where only 18.5% of families had children managing solid waste, [16]. Concerning waste disposal, around 40.7% of participants declined to utilize it, while 24.1 percent dumped it in an open place. Also, 57.7% of participants collect trash outside their homes, causing diarrhea, whereas 42.3% correctly dispose of their waste. Furthermore, another research highlighted that 95.6% of households correctly disposed of waste, which can reduce diarrheal prevalence [8].

Conclusion

This study shows an association between sanitation practices and diarrhea in children under five years old in both IDP and host communities in the Hodan district. Those with diarrhea had been under 35 months, the results revealed poor sanitation facilities and those sanitation factors associated with diarrhea include open-pit latrines with no slabs, water treatment, government housing, hygiene status among children, and flies seen in the kitchens. The majority of people lived in overcrowded neighborhoods with a high number of IDP families, rendering them more vulnerable to parasites and diarrhea due to poor sanitation conditions. Each household needs adequate latrines, safe drinking water, a waste disposal system, and improved hygiene practices. Multiple-family buildings had less sanitary facilities than single-family apartments, which require appropriate WASH services.

Our study findings recommended raising awareness among children under 35 months in the Hodan district, providing adequate water, sanitation, and hygiene services, and promoting proper handwashing practices among caregivers, children, and residents of the Zona-K IDPs area and the host community at the study site. Establishment of health promotion sessions at the household level to educate caregivers and children under the age of five about the effects of diarrhea and the importance of the availability of adequate sanitary facilities is recommended. Also, we recommended

conducting further research on the association between diarrheal diseases and sanitation factors at the study site.

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References

[1]. Rah JH, Cronin AA, Badgaiyan B, Aguayo V, Coates S, Ahmed S. Household sanitation and personal hygiene practices are associated with child stunting in rural India: A cross-sectional analysis of surveys. BMJ Open. 2015;5(2).

[2]. Behailu Melese, Wondimagegn Paulos, Feleke Hailemichael Astawesegn and Temesgen Bati Gelgelu*. Prevalence of diarrheal diseases and associated factors among under-five children in Dale District, Sidama zone, Southern Ethiopia: a cross-sectional study. BMC Public Health (2019) 19:1235. 2019.

[3]. Agustina R, Sari TP, Satroamidjojo S, Bovee-Oudenhoven IM, Feskens EJ, Kok FJ. Association of food-hygiene practices and diarrhea prevalence among Indonesian young children from low socioeconomic urban areas. BMC Public Health. 2013;13(1).

[4]. Berhe AA, Aregay AD, Abreha AA, Aregay AB, Gebretsadik AW, Negash DZ, et al. Knowledge, Attitude, and Practices on Water, Sanitation, and Hygiene among Rural Residents in Tigray Region, Northern Ethiopia. 2020.

[5]. Kumar A. Households' Toilet Facility in Rural India: Socio-spatial Analysis. 2017;

[6]. Mihrete TS, Alemie GA, Teferra AS. Determinants of childhood diarrhea among under-five children in Benishangul Gumuz Regional State, North West Ethiopia. 2014;

[7]. Gessesse DN and Tarekegn AA. Prevalence and associated factors of diarrhea among under-five children in the Jawi district, Awi Zone Ethiopia, 2019. Community based comparative cross-sectional study. Front. Pediatr. 10:890304. doi: 10.3389/fped.2022.890304. 2022.

[8]. Sahiledengle B, Alemseged F, Belachew T. Sanitation practice and associated factors among slum dwellers residing in urban slums of Addis Ababa, Ethiopia: A community based cross-sectional study. 2018.

[9]. Id SY, Hudani A, Udenigwe O, Shah V. Improving Water, Sanitation and Hygiene Practices, and Housing Quality to Prevent Diarrhea among Under-Five Children in Nigeria.

[10]. Yusuf AM, Sheikh A, Omer M, Yasin S omer, Had HJ. Prevalence and Factors Associated with Diarrhoea Among Childern Aged 0-59 Months in Badbaado Camp in Mogadishu, 2018.

[11]. Alasow A, Yusuf Abdirizak. Knowledge, Attitudes and Practices on Sanitation Among Women of Reproductive Age at Badbado Camp, Dharkenley District, Mogadishu-Somalia. CAJPH. 2020;6(4):220.

[12]. Mohamed H. Prevalence of Diarrhea and Associated Factors Among Children Under Five Years in Internally Displaced Populations of Hodan District, Somalia. 2019.

[13]. Dahir O, Boonshuyar C. Environmental determinants of reported diarrhea among under 5-year-old children in Mogadishu, Somalia. 2020.

[14]. Biniyam S, Fessahaye A, Tefera B. Sanitation practice and associated factors among slum dwellers residing in urban slums of Addis Ababa, Ethiopia: A community based cross-sectional study. Journal of Public Health and Epidemiology. 2018;10(10):370–9.

[15]. Eshete Soboksa N, Nenko Yimam G. Assessment of Household Level Sanitation Practice of Mothers' and Associated Factors in Gedeo Zone, South Ethiopia. American Journal of Public Health Research. 2017;5(2):43–9.

[16]. Bizatu M, Negga Baraki. Community based assessment on household management of waste and hygiene practices in Kersa Woreda, Eastern Ethiopia. 2010.

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Marketing Strategies Affect the Decision of Users of the Sport Science Center, National Sport University

Amnuay Pheeysiri [1], Thaweesub Koeipakvaen [1]* and Pakkawat Sertbudra [1]

[1] *Faculty of Education, Naresuan University, Thailand 65000*

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***Corresponding author:**
Thaweesub Koeipakvaen, Faculty of Education, Naresuan University, THAILAND 65000

E-mail:
Thaweesub@yahoo.co.th

ABSTRACT

Introduction: The National Sport University has a role to provide technical and resources to improve people's health. The study aimed to determine factors related to marketing strategy that affected a decision to use resources of the sport science center at the National Sports University.

Method: A cross-sectional study was used to collect data among the study sample who were the sport science center users. A validated questionnaire and interview guide were used as the research instruments. Data were analyzed using frequency, percentage, mean, and standard deviation.

Results: A total of 396 officers who used the services participated in the study. Majority of the participants were males (60.1%), aged between 20-30 years (45.7%), holding or being studying a bachelor degree (64.1%), and being students (31.3%). The overall marketing mix factors affecting the users' decision to the sport service was high. Both personal and process factors were detected at a high level. Seven strategies were found to be effective to improve the service: product, price, distribution channel, marketing promotion, personnel, physical evidence and process.

Conclusion: The National Sports University should focus on the personnel and process to improve the effectiveness of the service. The university should also concern all seven aspects to improve the sport service.

Keywords: Marketing strategy, Decision, Service user

Introduction

Nowadays, people in Thailand have a better economic status and are able to spend their time getting better health. Exercise is one of the most favorite behaviors in their daily life activities to improve their health. There are widely provided sports centers in both public and private sectors. The Thailand government has also promoted the specific policy to encourage people to engage in sport regularly. This is clearly presented in the Part Four of the National Development Strategy on the Strategy One Enhancement and Development of Human Capital Potential (Goal Four) which is stated to promote people health by exercise to reduce the risks of health problems (Office of the National Economic and Social Development Board Office of the Prime Minister 2016). The 6th National Sports Development Plan (2017-2021) is also focused on Thai citizens' health improvement by sports. Obviously, sport could improve people's health and then reduce the national medical expenses or the cost of healthcare services of the country eventually [1]. Having a good stage of health, it reflects the quality of human resources of a nation to be able to drive the country economically (Sitthichai Chumwangwapi, 2008).

The National Sports University has a major role in the improvement of sport resources and services to people. The main functions include testing physical fitness, organizing training programs to enhance physical fitness for athletes and providing the services in both teaching and training for general exercise. The university needs to improve both the quality and quantity of exercise resources and services to ensure that people could easily access the services. However, it was reported that a small proportion of people engaged in the services of the university. Then understanding its market and services could improve the number of people to access the services of the university.

To improve the service, marketing would be one of the critical points. There are seven elements of marketing that required to focus: (1) products which is

determined on the quality, safety, sufficient, and being modern style of the equipment; (2) price which is determined on the cost to access the services including membership registration; (3) channel of the services and location which are determined on the space of the service and service time that appropriate for the users; (4) marketing promotion which is determine on the promotion to encourage people to decide to use the service; (5) personnel which is determined on the service mind of the staff including the knowledge and skill on their services to their customers; (6) physical evidence which is determined on the cleanliness of the place and bathroom, adequacy of , rooms and its safety while using and; (7) process which is determined on necessary step of service to their customers.

Then, the study aimed to use seven elements of marketing strategies to assess the quality of the services of the university.

Methodology

A cross-sectional was used for data collection. The users at the Sports Science Center of the National Sports University, Thailand were invited to participate in the study. In 2021, more than 36,000 users were recorded. The samples were collected from four regional sport centers in Thailand: (1) northern region, the samples were collected from Chiang Mai sport campus (11,470 users); (2) central region, the samples were collected from Ang Thong sport campus (8,310 users); (3) northeastern region, the samples were collected from the Chai Ya Phum sport campus (10,414 users); and 4) southern region, the samples were collected from : Ya La sport campus (5,820 users).

The sample size was calculated by the standard formula of a cross-sectional study, and it required 396 samples.

A validated questionnaire was used for collecting data. The questionnaire consisted of two parts. Part one, five questions were used to collect general information of the participant. Part two, seven sub-topics of the marketing strategies were included: (1) products, (2) prices, (3) location of service, and (4) marketing promotions, (5) personnel, (6) physical evidence, and (7) processes.

First, participants were asked five questions regarding the produces: (a) Having many types and sizes of exercise equipment; (b) Equipment have a quality and modernizing; (c) Having sufficient quantity of exercise equipment; (d) Exercise have presented cleaning and safety; and (e) Equipment meet the needs of users. Then the participants were asked to respond on one of five rating scales from poor to very satisfactory.

Second, participants were asked five questions regarding the price of services, participants were asked five questions: (a) Having subscription suitable rates for the services; (b) Having reasonable rates while comparing to the quality of the equipment; (c) Having reasonable rate for one time/monthly/yearly; (d) Having a notice for membership fees or expenses clearly; and (e) Having value/reasonable while comparing to the services.

Third, participants were asked four questions regarding the location of the services, participants were asked five questions: (a) The location is near the residence or workplace; (b) Traveling to services easily and quickly; (c) Having fast entrances and exits to the location; and (d) Having enough and convenient parking place.

Fourth, participants were asked five questions regarding the marketing promotion, participants were asked five questions: (a) It is advertised and promoted by brochures/websites; (c) Having public relations/news/activities regularly; (c) Having public attraction; (d) Always disseminating knowledge about exercise; and (e) Having promotions at special prices/discount prices or give gifts.

Five, participant were asked five questions regarding the personnel, participants were asked five questions: (a) Service personnel are courteous, speak politely, considerate, generosity; (b) Service personnel are attentive, enthusiastic and ready to serve; (c) Service personnel are knowledgeable and have the ability to provide services such as being able to answer questions, clarify doubts and give advice; (d) Officers provide services with honesty in their performance of duties such as not asking for compensation, not accepting bribes, not seeking unlawful benefits, etc; (e) Service personnel come to work on time.

Six, participants were asked five questions regarding physical evidence, participants were asked five questions: (a) It is clean, spacious and well ventilated; (b) There are toilets that are hygienic/clean enough and have separate male-female sections; (c) There are separate changing rooms for men and women that are suitable, safe and adequate; (d) There is a service that is safe for the property; (e) There is an adequate supply of service points, such as arranging a resting corner for sitting and waiting or sit and read a book.

Last, participants were asked four questions regarding the process of the services, participants were asked five questions: (a) The service process is not complicated, cumbersome and it is flexible; (b) The services are convenient and fast; (c) Service is provided on a first-come, first-served basis, back and equal; and (d) It is convenient and fast to pay for the services.

Process of data gathering

People who accessed the services in four selected sport campuses in 2021 from the lists were randomly selected. Selected participants were requested in response to the questionnaire. Before completing the

questionnaire, participants were provided information about the study and asked to sign on the consent form.

Statistical analysis

Data were cleaned and entered into the excel. Data were analyzed and presented in the form of frequency, mean, SD.

Results

A total of 396 participants participated in the study. Majority were male (60.1%), aged 20-30 years (45.7%), holding or studying a bachelor degree (64.1%), and being students (31.3%) (Table 1).

Table 1 Characteristics of participants

Characteristics	n	%
Total	396	100.0
Sex		
Male	238	60.1
Female	159	39.9
Age (year)		
< 20	47	11.9
20-30	181	45.7
31-40	110	27.8
>40	58	14.6
Education		
Under Bachelor degree	77	19.4
Bachelor degree	254	64.1
Master degree	61	15.4
Doctoral degree	4	1.0
Occupation		
Student	124	31.3
Private company employee	84	21.2
Government officer	103	26.0
Business owner	82	20.7
Other	3	0.8

According to the seven elements of the market strategy, the personal and process were found to have the highest impact on deciding to use the sport services: Personal (4.49). and process (4.49). While the promotion was detected in the lower power (3.92) on the decision of users to access the services. However, in terms of the overall interpretation, all seven elements of the market strategy impacted the decision on whether to use or not use for the sport service at a high level.

Table 2 Access sport service according to the seven market strategies (n=396)

Marketing strategies	Score		Decision level
	mean	SD	
Product size	4.34	0.69	High
Price	4.33	0.66	High
Distribution channels	4.38	0.65	High
Promotion	3.92	0.85	High
Personnel	4.49	0.61	High
Physical evidence	3.97	0.93	High
Process	4.49	0.59	High

Discussion

The overall participants were males and younger. This may be because males have more personal intention to have physical fitness and keep themselves in a healthy stage. Males may earn more income than they would be able to access the sport services. Moreover, our study found that students were detected as the dominant in access to the sport service. This might be because the students have a very clear class schedule and are able to spend time exercising. This coincides with the study of Dechasetsiri (2018) who reported that being males, younger age, and having were the influencing factors to aces sport clubs in Bangkok city. A study conducted by Amorn and Kultawachawichai (2012) reported being male, aged 18-25 years, having a bachelor's degree, having a career as a student, and having an average monthly income of 5,000-25,000 baht per month were predicted factors to engage in sport service. In the report, it was also presented that location was one of the significant factors to support people to use sport service.

While Wongsawat (2011) reported that those people aged 36-45 years, and being business men and having high income were the traits of the people who engaged into the sport service in the big cities. A study conducted by Srisilp (2015) reported that there were no differences between sex to access the sport service. Srisilp also reported that people preferred to exercise with simple machines in private sport centers. The location was one important to access the sports center as well.

A study conducted by Kamolsuth et at. (2007) also reported that the majority of people who accessed the sport center were males, aged between 19-25 years, single status, bachelor's degree holders, and working in private company employees with average income of 25,000 baht or more. While the location and registration fee or service fees of the sport center were detected as the key factor of continuing in exercise.

While a study conducted by Phungbangkruai (2009) reported that the marketing promotions were a significant factor in increasing the number of users. While the factors of location, modernized style of the center or other physical evidence were the significant supporting factors to access the sport services including a variety of the activities or exercise equipment. While, the personnel and location factors were found as the key factor for continuing use the services and paying a long-service use registration fee.

Jai-ngam (2016) reported that personnel in the center with a good appearance was a key factor to use the sport service. While the price, location and process were also detected as the significant factors of the success of the sport services. This coincides with a study conducted by Somboonwan (2015), who reported that personnel, building and location, process, and price

were the influencing factors to access the services. Thanchot (2019) also reported that the three top factors related to deciding to use the service were personnel, products, and location. Wongsawat (2011) reported that product, service aspect and location were the influencing factors to access the sport services. Chapromma (2017) reported that factors affecting the decision-making of users were promotion, service equipment, location, convenience, price and personnel.

Conclusion

Even Thai people interested in exercise to keep their health, there are many factors affecting the personal decision to access the sport service. Male, younger age, and high education are more focusing on improving their health than other characteristics. To increase the sport service, the center should keep qualified personnel and reduce unnecessary processes to all services. Personal who are working in the service should be the ones who have a service mind. While, the process of the services should be kept simple and easier.

However, encouraging other age categories and females are one of the challenges of the university to promote the healthy stage of Thai population. Distribution of the locations to be easy for access for everyone would be one important strategy.

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References

[1] Ministry of Tourism and Sports. (2016). National Sports Development Plan No. 6 (2017 -2021). Bangkok: Office of Printing Works of the War Veterans Organization

[2] Jirasak Chapromma. (2017). Factors influencing the decision to use the service of an open fitness center. Provide 24-hour service for consumers in Bangkok. Master of Business Administration Thesis, Faculty of Commerce and Accountancy, Thammasat University.

[3] Jirapha Puengbangkruai. (2009). Service Marketing Mix Influences Decision Making. Fitness center in Bangkok. Golden Teak: Journal of Humanities and Social Sciences, Kamphaeng Phet Rajabhat University, 5(1), 76-90.

[4] Chanudon Teerawatanamon and Thepprasit Kunthawat Wichai. (2012). Demand for road mix. Sports and fitness consumer marketing in the National Stadium. Journal of Sports Science and Health, 13 (3), 52-64.

[5] Noraset Kamolsuth, Jirawut Lumprakhon and Jiraporn Angsuwirotkul. (2006). Factors influencing Behavior of decision to apply for fitness center membership. Department of Marketing, UniversitySiam. Accessible from http://www.siam.edu/siamedu_thai_mainpage/images/stories/article/2550_bus12.doc

[6] Mukdawan Somboonwan. (2015). Factors influencing the decision to use the fitness center service. Large body (Fitness Center) of the population in Bangkok. Master of Business Administration Thesis, Business Administration, Thammasat University.

[7] Methapat Dechasetsiri. (2018). Factors affecting the decision to use a fitness center of the people of Bangkok. Master of Management Thesis, College of Management, Mahidol University.

[8] Pakorn Wongsawat. (**2011).** Factors influencing the decision to use the fitness center of consumer

[9] Sivaporn Srisilp. (2015). A study of the behavior of decision making in choosing a service. and project evaluation Fitness Center for daily exercise Mueang Nonthaburi District. (Independent research, Master's degree). Bangkok: Thammasat University.Office of the National Economic and Social Development Board Prime Minister's Office (2016). National Economic and Social Development Plan Twelfth Edition (2017 – 2021).

[10] Apichaya Thanachot. (2019). Marketing mix factors affecting the decision to use the service. Health exercise business establishments. Master of Arts thesis, Major in Sports Management, Naresuan University.

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Comparative Effects of Arm Cycle Ergometer and Leg Cycle Ergometer on Vital Capacity, Blood Pressure, and Resting Heart Rate in Sedentary Adolescents

Thanyawat Homsombat [1], Wisutthida Saengjan [2*]

[1]Lecturer, Faculty of Sports Science and Health, Thailand National Sports University, Udon Thani Campus, Thailand
[2]Health Science Program, Faculty of Science and Technology, Nakhon Sawan Rajabhat University, Nakhon Sawan, Thailand

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***Corresponding author**:
Wisutthida Saengjan, Health Science Program, Faculty of Science and Technology, Nakhon Sawan Rajabhat University, Nakhon Sawan, Thailand

E-mail:
cmu_kku@hotmail.com

ABSTRACT

Introduction: A cycle ergometer is a stationary machine that enables cyclic rotations and can be used to carry out passive, active, and resistance exercises. Cycle ergometry promotes early healing and increases the individual's functional ability; lung capacity, blood pressure, and cardio-pulmonary endurance while they are sedentary. The experimental study aimed to investigate the comparative effects of arm cycle ergometers and leg cycle ergometers on vital capacity, blood pressure, and resting heart rate in adolescent sedentary subjects.

Methods: Participants were twenty-eight male adolescents who do not have regular physical activity and were divided into 2 groups; leg cycling (n=14) and arm cycling (n=14). On the first occasion and post-trial, participants were evaluated for their vital capacity, systolic and diastolic blood pressure, and resting heart rate. Both intervention conditions were performed for 60 minutes (10 mins for warm-up, 40 mins for exercise, and 10 mins for cooldown), three times per week for 8 weeks. Descriptive statistics were frequency, percentage, mean, and standard deviation. The inferential statistic was an independent t-test used to compare vital capacity, heart rate, systolic blood pressure, and diastolic blood pressure after 8 weeks (post-test) in the arm cycling group and the leg cycling group at a 95% confidence interval.

Results: The resting heart rate and the diastolic blood pressure of the arm cycling group were significantly different from the leg cycling group (p-value=0.002 and p-value=0.010, respectively). Conversely, the vital capacity and the systolic blood pressure of the arm cycling group were not significantly different from the leg cycling group (p-value=0.290 and p-value=0.480, respectively).

Conclusions: According to the present study, confirmed that this program has beneficial effects for improved cardiorespiratory fitness and decreased diastolic blood pressure in adolescent sedentary subjects.

Keywords: Arm cycle ergometer, Leg cycle ergometer, Vital capacity, Blood pressure, Resting heart rate

Introduction

In developed countries, sedentary lifestyles are prevalent among children and adolescents [1] with fewer active leisure activities and a greater emphasis on sedentary activities [2]. Sedentary activities, especially those centered on the use of electronic devices, are linked to an increased risk of obesity and a decline in physical fitness, regardless of physical activity levels [3]. Numerous studies, however, have demonstrated a strong correlation between children's and adolescents' functional capacities and levels of physical activity and fitness [4].

Functional exercises all over the body, especially running or cycling, would result in an increase in the rate of oxygen consumption, including lung capacity, blood pressure [5], and cardio-pulmonary endurance [6] are an important test of athletes' abilities used to estimate the maximum oxygen utilization rate ($VO2_{max}$) [7]. The maximum oxygen consumption rate ($VO_{2\ max}$) is the maximum amount of oxygen that an individual can

utilize during maximal intensity exercise, which is the measurement that is commonly considered the best indicator of the exercise capacity of the individual [8] and physical inefficiency [9]. Exercise on a treadmill or leg cycle ergometer is usually an examination for cardiorespiratory endurance. However, some previous studies revealed several reasons for the replacement of leg exercise with cycling to test cardiorespiratory endurance [10]. For instance, Vanhees, et al [11] suggested that the maximal oxygen utilization rate test should be performed with arm cycling to serve as an alternative to testing upper body performance for athletes who may have difficulty in leg cycling exercise [12]. Nevertheless, some studies have found that cycling with arms has limitations among athletes who did not receive regular exercise training. When examined using arm cycling, there was a relatively low rate of maximal oxygen consumption and no increase in cardiopulmonary effort [13], compared to leg cycling [14]. In addition, it was also found that there was less muscle mass, and reduced cardio and lung endurance during the arm cycling exercise. External factors, such as the presence of lactic acid, immediately limit the work of the heart and blood vessels. In addition, Walker et al [15] also found that upper and lower limb exercises had a statistically significant difference in maximal muscle power due to both exercises stimulating the work of the heart and blood vessels more. Bronas, et al [16] also found that both arm cycling and treadmill running affected cardio-pulmonary endurance in 28 ischemic leg pain patients as well as increased the maximum oxygen consumption rate, maximum respiratory rate, and maximum power from arm cycle ergometer compared to arm crank ergometer exercises [17]. In addition, the total exhaled air volume after normal exhalation, the volume of air flowing into and out of the lungs per breath, and the maximum oxygen consumption rate are lower than that of leg cycling in healthy subjects [18].

According to previous studies, it can be seen that there are a wide variety of studies and methods related to exercise. However, few studies have compared and clarified the effects of arm and leg cycling on functional performance in non-exercise adults. Therefore, the researchers are interested in studying the comparative effects of arm cycle ergometers and leg cycle ergometers on blood pressure, vital capacity, and resting heart rate in adolescent sedentary subjects. The research hypothesis is that the effect of arm cycling affects blood pressure, vital capacity, and resting heart rate are different from leg cycling. It may be a guideline for choosing an exercise regimen for healthy people who do not exercise regularly. This study's findings may serve as a guideline for selecting suitable exercise programs for sedentary individuals who do not engage in regular physical activity.

Methodology

Participants

Twenty-eight men adolescents who do not have regular physical activity were selected by purposive random sampling and were divided into 2 groups; arm cycling (n=14) and leg cycling (n=14). It was obtained by calculating the sample size using the G*power program. The screening was used as a standard evaluation based on the "FITT" by the American College of Sports and Medicine [19]. The Physical Activity Readiness Questionnaire (PAR-Q) was used to identify potential risk factors that could impair their capacity to exercise safely. All of the participants stated that they were right-handed and did not use corrective lenses. Age (18-35 years) and body mass index (BMI)< 23.0 kg/m2, were used as a criterion for inclusion. Self-reported history of mental, neurological, cardiovascular, or pulmonary disorders, orthopedics pathology, or musculoskeletal dysfunctions were all considered exclusion criteria.

Intervention

Both conditions were performed 60 minutes three times per week (Monday, Wednesday, and Friday; 09.00-10.00) for 8 weeks. The ergometer was secured to a strong table for the arm cycling experiment, and the foot pedals were substituted with pronated-position hand grips. The ergometer's height could be adjusted, allowing the crank axis to be aligned with the glenohumeral joint's center as follows:

The arm cycling training program (Monark 881E, Vansbro, Sweden) included 60 minutes of exercise with arm cycling at 20 W for warm-up (10 mins), then 4 times per round of the arm-cycling procedure included 35 W of initial power output, followed by 20 W increments every 3 minutes until volitional exhaustion was reached and 1 minute of recovery between rounds and cool down 10 minutes [20].

The leg cycling training program (Lode Excalibur Sport Ergometer, Lode B.V., Netherlands) included 60 minutes of exercise with leg cycling at 50 W for warm-up (10 mins), then 4 times per round of the leg-cycling procedure included 70 W of initial power output, followed by 35 W increments every 3 minutes until volitional exhaustion was reached and 1 minute of recovery between rounds and cool down 10 minutes [20].

Outcome measurements

On the first occasion, the participants underwent familiarization. It also served as a habituation test to familiarize participants with arm-cycling. Then, the participants were evaluated for their vital capacity, systolic and diastolic blood pressure and resting heart rate (baseline). Across all variables, the participants took measurements using standardized protocols. Started an experimental period of parallel 2 conditions for 8 weeks and re-evaluated their vital capacity, systolic and diastolic blood pressure, and resting heart rate (after 8 weeks) as follows:

For vital capacity (VC), Measurement of vital capacity was performed as described by the American Thoracic Society and by the European Respiratory Society [19]. It is the total amount of air exhaled after maximal inhalation (Spiropet spirometers T20) (ml). All participants were familiarized with the equipment and procedures before testing. The measurement was taken when the participants were relaxing in the standing position with a nose clip. The participants have performed at least three times to take the best value to analyze the data.

For blood pressure (BP) including systolic blood pressure (SBP) and diastolic blood pressure (DBP) (mm Hg). BP was measured twice with participants in the sitting position after a rest of at least 5 minutes using an autonomic BP monitor (Omron HEP-1300). The mean of the two measurements was used for analysis. The researchers who had undergone training used automated and calibrated electronic BP monitors (Omron HBP-1300) to assess office BP at baseline and after 8 weeks

Resting heart rate (RHR): Heart rate was obtained at rest in sitting position and during the exercise protocol using a Polar Heart Rate Monitor (Lake Success, NY). HR data were stored in the internal memory of the Polar H10 HR sensor. Polar Beat version 2.4.5 for Android (Polar Electro Oy, Kempele, Finland) was loaded on each participant's phone for transferring HR data from H10 through Bluetooth. After each test protocol was performed, data was provided, and HR was assessed using Polar Flow (Polar Electro Oy, Kempele, Finland).

Statistical analysis

Statistical analysis used STATA 13 (Texus, USA, 2007). The S-Wilk test was used to test the normal distribution of values. Descriptive statistics were frequency, percentage, mean, and standard deviation to express age and body mass index. The inferential statistic was an independent t-test used to compare vital capacity, heart rate, systolic blood pressure, and diastolic blood pressure after the trial (post-test) in the arm cycling group and the leg cycling group at 95% confidence interval. We used α=0.05 as the cut-off point of statistical significance [21].

Results

Age and body mass index (baseline)

Twenty-eight male adolescents were divided into 2 groups; the leg cycling group (n=14) had a mean age of 27.57 (SD=3.18) years old and a body mass index of 22.10 (SD=1.19) and the arm cycling group (n=14) had a mean age of 22.43 years old (SD=2.73) and a body mass index of 21.54 kg/m2 (SD=1.45) (Table 1).

Table 1 Age and body mass index

Variable	Leg cycling group	Arm cycling group
	Mean/SD (n=14)	Mean/ SD (n=14)
Age (years)	27.57/3.18 Min/Max: 19/31	22.43/ 2.73 Min/Max: 19/28
BMI (kg/m^2)	22.10 (1.19) Min-Max: 19.18/22.55	21.54 (1.45) Min/Max: 19.38/23.00

Vital capacity, resting heart rate, and blood pressure
(a) Baseline of all variables

At the baseline, found that all variables of the arm cycling group were not significantly different from the leg cycling group (p-value = 0.330, p-value= 0.080, p-value= 12, and p-value=0.220, respectively) (Table 2).

Table 2 Baseline of all variables

Variables	Leg cycling group	Arm cycling group	p-value
	Mean/ SD (n=14)	Mean/SD (n=14)	
Vital capacity	3211.31	3256.98	0.330
Resting heart rate	83.86	86.82	0.080
Systolic blood pressure	114.32	115.11	0.120
Diastolic blood pressure	72.14	74.25	0.220

(b) Vital capacity after 8 weeks (post-test) in the arm cycling group and the leg cycling group

Using the S-Wilk test assumes that all the populations are normally distributed (p-value=0.180), all the population variances are equal and they are randomly collected from all the populations [22]. After 8 weeks (post-test), the vital capacities of the arm cycling group and the leg cycling group were 3242.85 and 3335.71, respectively. The results showed that the vital capacity of the arm cycling group was not

significantly different from the leg cycling group (p-value=0.290) (Table 3).

Table 3 Vital capacity after 8 weeks (post-test) in the arm cycling group (n=14)

Vital capacity	Two-sample t test with equal variances		t-test	p-value
	Mean	SD		
Leg cycling group (n=14)	3242.85	202.72	-1.06	0.290
Arm cycling group (n=14)	3335.71	256.02		

(c) Resting heart rate after 8 weeks (post-test) in the arm cycling group (n=14) and the leg cycling group (n=14)

After 8 weeks (post-test), the resting heart rate of the arm cycling and the leg cycling groups were 76.71 and 82.85, respectively. The results showed that the resting heart rate of the arm cycling group was significantly different from the leg cycling group (p-value=0.002) (Table 4).

Table 4 Resting heart rate after the trial (post-test) in the arm cycling group (n=14) and the leg cycling group (n=14)

Heart rate	Two-sample t test with equal variances		t-test	p-value
	Mean	SD		
Leg cycling group (n=14)	76.71	5.31	-3.42	0.002
Arm cycling group (n=14)	82.85	4.09		

(d) Systolic blood pressure after 8 weeks (post-test) in the arm cycling group (n=14) and the legs cycling group (n=14)

After 8 weeks (post-test), the systolic blood pressure of the arm cycling and the leg cycling groups were 115.85 and 115.14, respectively. The results indicated that the systolic blood pressure of the arm cycling group was not significantly different from the leg cycling group (p-value=0.480) (Table 5).

Table 5 Systolic blood pressure after 8 weeks (post-test) in the arm cycling group (n=14) and the leg cycling group (n=14)

Systolic blood pressure	Two-sample t test with equal variances		t-test	p-value
	Mean	SD		
Leg cycling group (n=14)	115.85	3.41	0.71	0.480
Arm cycling group (n=14)	115.14	1.56		

(e) Diastolic blood pressure after 8 weeks (post-test) in the arm cycling group (n=14) and the legs cycling group (n=14)

After the trial (post-test), the diastolic blood pressure of the arm cycling and the leg cycling groups were 72.71 and 80.00, respectively. The results indicated that the diastolic blood pressure of the arm cycling group was significantly different from the leg cycling group (p-value=0.01) (Table 6).

Table 6 Diastolic blood pressure after 8 weeks (post-test) in the arm cycling group (n=14) and the leg cycling group (n=14)

Diastolic blood pressure	Two-sample t test with equal variances		t-test	p-value
	Mean	SD		
Leg cycling group (n=14)	72.71	6.80	2.55	0.010
Arm cycling group (n=14)	80.0	6.22		

Discussion

According to the current findings, the leg cycling group had a mean age of 27.57 years old and a normal weight (BMI=22.10), while the arm cycling group had a mean age of 22.43 years old and a normal weight (BMI=21.54). The arm cycling group and the leg cycling group have vital capacities of 3242.85 and 3335.71, respectively. Our data also show that mean vital capacity was not significantly different during the leg cycling ergometer compared to arm cycling ergometer (p-value=0.290). However, previous meta analyses study found that when high-intensity interval exercise (HIIE) was long-term, it increased VO2max more than moderate-intensity continuous exercise (MICE) in both active people [23] and those with

chronic disease [24]. Furthermore, despite the higher intensities of HIIE compared to MICE, similar to Stork et al [25] and Olney et al [26] and in some cases greater post-exercise enjoyment has been reported, substantiating its broad application as an additional option for many adults to engage in physical activity [27, 28]. Previous research in active men shows that chronic HIIE arm cycling improves VO2max and time trial performance, but no studies have looked at the acute response to this modality or compared it to leg cycling [29]. The mean heart rate (HR) during arm cycling ergometer was significantly greater than during leg cycling ergometer, indicating a 'large effect' which is corroborated by previous graded exercise data showing a higher HR for combined leg/arm activity compared to arm exercise alone [30]. According to Astorino and Emma [31], confirmed that women had a higher heart rate during HIIE when compared to males (8–18 bpm higher, d = 1.3-3.3) and arm cycling ergometer (12-20 bpm higher, d = 2.4-4.0) (p-value=0.001) [32]. Furthermore, peak VO2 and heart rate do not alter between modes, implying that peak cardiorespiratory strain during HIIE is analogous to having various amounts of trained muscle mass during exercise. During isometric handgrip vs. cycling at comparable speeds heart rate (about 90 beats per minute). In addition, Bassett (2002) confirmed that the main reason for the gender difference in VO2max, a crucial factor in determining aerobic capacity, has been suggested as the reason why men do better in endurance exercises [33]. When expressed in mL/kg/min, even the most elite women have VO2max values that are almost 10% lower than those observed in men with comparable elite status [34]. Due to the increased oxygen demand from the working muscles, whole-body oxygen consumption (VO2) rises with increasing exercise intensity. Due to the increased oxygen demand from the working muscles, whole-body oxygen consumption (VO2) rises with increasing exercise intensity. Because practically all of the energy (ATP) used during an endurance exercise performance (aerobic exercise) will be resynthesized in the mitochondria through oxidative metabolism, there is an increase in oxygen demand [34]. Concurrently rising heart rate, ventilation, and stroke volume are just a few of the cardiovascular and respiratory parameters that rise with this surge in oxygen use. VO2 is essentially the capacity of the muscles to deliver and utilize oxygen when they are working out. Exercise intensity can be increased until VO2 hits a plateau known as VO2max that is unaffected by additional increases in exercise intensity [35]. Exercise tolerance is constrained by VO2max, which measures the maximum rate at which ATP may be produced again by aerobic pathways [36]. In 2008, Leicht and colleagues demonstrated the comparison between a rating of perceived exertion (RPE) and cardiorespiratory response to dynamic muscular exercise of different muscle groups at 50% and 65% maximal HR (HRmax) [37].

Our findings showed that blood pressure parameters during both arm cycling ergometer and leg cycling ergometer were not significantly different from the systolic blood pressure of the arm cycling group, whereas the diastolic blood pressure of the leg cycling group was significantly lower than the arm cycling group. There are only a few studies that compare the two thus far the pattern of cardiovascular response at identical heart rates [38] discovered a greater rise in SBP and DBP. The cause of the problem is assumed to be caused by three methods. During voluntary muscle contraction, neuronal cardiovascular modulation occurs contractions: higher brain areas are activated (in the middle compel) as well as reflex activity that is purely input-based from mechanoreceptors and chemo-receptors ('muscle metaboreflex') and the afferents of baroreceptors ('baroreflex') [39]. Each mechanism modifies the sympathetic and parasympathetic outflow from the cardiovascular control center by activating neural circuits within the medulla [40]. The impact of each mechanism on the heart rate and blood pressure response to exercise is determined by a variety of parameters, including recruited muscle mass, muscle fiber type, exercise intensity, and activity style [41]. Early research comparing the cardiovascular responses to static and dynamic muscular actions found that dynamic work causes significant increases in heart rate (HR), systolic arterial pressure (SBP), and minor changes in diastolic arterial pressure (DBP), whereas isometric work causes only modest increases in HR but significant increases in SBP and, in particular, DBP [41]. However, the generalizability of these findings is limited because a) the cardiovascular effects of static (SE) and dynamic (DE) exercise have been investigated independently; and b) it is difficult to quantify and thus equate workload during different exercise modes [40] and c) the muscles being compared were frequently of different sizes and locations. Similar heart rate and blood pressure responses were evoked by static vs. dynamic contractions of identical tiny muscles, such as during submaximal handgrip exercise [40], while it was show that submaximal isometric contractions of bigger muscles (e.g. knee extensors/flexors) at 40% of maximum effort have been found to cause lower heart rate and blood pressure responses than isokinetic or isotonic contractions [41]. During moderate exercise intensity, Chapman and Elliott (1988) [42] found a significant increase in heart rate and systolic blood pressure during dynamic exercise, while diastolic blood pressure was highest during static exercise.

Conclusions

In summary, although healthy sedentary' resting heart rates and diastolic blood pressure may decrease, other characteristics will not significantly change as a result. However, the findings of this study can offer suggestions for selecting suitable exercise programs for inactive individuals who don't engage in regular

physical activity. To demonstrate the significance of arm and leg cycling in promoting another sedentary subject, more studies are required.

References

[1] Chen X, Sekine M, Hamanishi S, et al. Lifestyles and health-related quality of life in Japanese school children: a cross-sectional study. Prev Med. 2005; 40(6): 668–78.

[2] Gopinath B, Hardy LL, Baur LA, et al. Physical activity and sedentary behaviors and health-related quality of life in adolescents. Pediatrics. 2012; 130(1): e167–74.

[3] Tremblay MS, LeBlanc AG, Kho ME, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. Int J Behav Nutr Phys Act. 2011; 41(6 Suppl 3): S240-65.

[4] Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010; 7(40): 1-17.

[5] Herdy AH, Uhlendorf D. Reference values for cardiopulmonary exercise testing for sedentary and active men and women. Arq Bras Cardiol. 2011; 96(1): 54-59.

[6] Paap D, Takken T. Reference values for cardiopulmonary exercise testing in healthy adults: A systematic review. Expert Rev Cardiovasc Ther. 2014; 12(12): 1439-1453.

[7] Stickland MK, Butcher SJ, Marciniuk DD, Bhutani M. Assessing Exercise Limitation Using Cardiopulmonary Exercise Testing. Pulm Med. 2012(19). 2012; 1-13.

[8] Steins Bisschop CN, Velthuis MJ, Wittink H, et al. Cardiopulmonary exercise testing in cancer rehabilitation: a systematic review. Sports Med. (Auckland, N.Z.). 2012; 42(5): 367-379.

[9] Young EL, Karthikesalingam A, Huddart S, et al. A systematic review of the role of cardiopulmonary exercise testing in vascular surgery. Eur J Vasc Endovasc Surg. 2012; 44(1): 64-71.

[10] Albouaini K, Egred M, Alahmar A. Cardiopulmonary exercise testing and its application. Postgrad Med J. 2007; 83(985): 675-682.

[11] Vanhees L, De Sutter J, Gelada SN, et al. Importance of characteristics and modalities of physical activity and exercise in defining the benefits to cardiovascular health within the general population: recommendations from the EACPR (Part I). Eur J Prev Cardiol. 2012; 19(4): 670-686.

[12] Orr JL, Williamson P, Anderson W, Ross R, McCafferty S, Fettes P. Cardiopulmonary exercise testing: Arm crank vs cycle ergometry. Anaesthesia. 2013; 68(5): 497-501.

[13] Secher NH, Volianitis S. Are the arms and legs in competition for cardiac output? Med Sci Sports Exerc. 2006; 38(10): 1797-1803.

[14] Loughney L, West M, Pintus S, et al. Comparison of oxygen uptake during arm or leg cardiopulmonary exercise testing in vascular surgery patients and control subjects. Br J Anaesth. 2014; 112(1): 57-65.

[15] Walker RD, Nawaz SH, Wilkinson C, Saxton J M, Pockley AG, Wood RF. Influence of upper- and lower-limb exercise training on cardiovascular function and walking distances in patients with intermittent claudication. J Vasc Surg. 2000; 31(4): 662-9.

[16] Bronas Ulf Gunnar. Diane Treat-Jacobson, Arthur S Leon. Comparison of the effect of upper body-ergometry aerobic training vs treadmill training on central cardiorespiratory improvement and walking distance in patients with claudication. J Vasc Surg. 2011; 53(6): 1557-64.

[17] Mitropoulos A, Gumber A, Crank H, and Klonizakis M. Validation of an arm crank ergometer test for use in sedentary adults. J Sports Sci Med. 2017; 16(4): 558-564.

[18] Tiller NB, Ian GC, and Lee MR. Mechanical-ventilatory responses to peak and ventilation-matched upper- versus lower-body exercise in normal subjects. Experimental Physiology. 2019; 104(5): 920–931.

[19] Munro BH. Statistical methods for health care research (5th ed.). Philadelphia: Lippincott Williams & Wilkins.

[20] American College of Sports Medicine. ACSM'S guidelines for exercise testing and prescription. 10th ed. Lippincott Williams and Wilkins (latest edition), 2020.

[21] Hill MW, Goss-Sampson M, Duncan MJ, Price MJ. The effects of maximal and submaximal arm crank ergometry and cycle ergometry on postural sway. Eur J Sport Sci. 2014; 14(8); 782–790.

[22] Stork MJ, Banfield LE, Gibala MJ, and Martin KA. A scoping review of the psychological responses to interval exercise: is interval exercise a viable alternative to traditional exercise?. Health Psychol. Rev. 2017; 11(9). 324-344.

[23] Olney N, Wertz T, LaPorta Z, Mora A, Serbas J, and Astorino TA. Comparison of acute physiological and psychological responses between moderate intensity continuous exercise and three regimes of high intensity training. J Strength Cond Res. 2018; 32(3). 2130–2138.

[24] Miller WR and Rollnick S. Motivational interviewing: Preparing people for change. New York: Guilford Press, 2002.

[25] Milanovic Z, Sporis G, and Weston M. Effectiveness of high-intensity interval training (HIT) and continuous endurance training for VO2max improvements: a systematic review and meta-analysis of controlled trials. Sports Med. 2015; 45(7). 1469–1481.

[26] Weston M, Taylor KL, Batterham AM, Hopkins WG. Effects of low-volume high-intensity interval training (HIT) on fitness in adults: a meta-analysis of controlled and non-controlled trials. Sports Med. 2014; 44(7):1005-17. doi: 10.1007/s40279-014-0180-z.

[27] Thum JS, Parsons G, Whittle T, and Astorino TA. High-intensity interval training elicits higher enjoyment than moderate intensity continuous exercise. PLoS One. 2017; 12(1). 1-11.

[28] Astorino TA, and Emma D. Differences in physiological and perceptual responses to high intensity interval exercise between arm and leg cycling. Front Physiol. 2021; 12(8): 1-9.

[29] Oliveira BRR, Santos TM, Kilpatrick M, Pires FO, and Deslandes AC. Affective and enjoyment responses in high intensity interval training and continuous training: A systematic review and meta-analysis. PLoS One. 2018; 13(16). 1-17.

[30] Bassett DR. Scientific contributions of A V Hill: exercise physiology pioneer. J Appl Physiol. 2002; 93(5):1567-82.

[31] Coyle EF. Physiological determinants of endurance exercise performance. J Sci Med Sport. 1999; 2(3): 181-9.

[32] Joyner MJ and Dominelli PB. Central cardiovascular system limits to aerobic capacity. Exp Physiol. 2021; 106(12): 2299-2303.

[33] Jones A. Sports science and coaching the physiology of the world record Holder for the women's marathon. Int J Sports Sci Coach. 2006, 1(2), 101–116.

[34] Leicht AS, Sinclair WH, Spinks WL. Effect of exercise mode on heart rate variability during steady state exercise. Eur J Appl Physiol. 2008; 102(11): 195-204.

[35] Zinner C, Morales-Alamo D, Ørtenblad N, Larsen FJ, Schiffer TA, Willis SJ, et al. The physiological mechanisms of performance lower extremities in humans. Front. Physiol. 2016; 7(426). 1-9.

[36] Hoffmann MD, Kassay KM, Zeni AI, and Clifford PS. Does the amount of exercising muscle alter the metabolic demand of dynamic exercise? Eur J Appl Physiol. 1996; 74(11). 541–547.

[37] Lindquist VA, Spangler RD, Blount SG Jr. A comparison between the effects of dynamic and isometric exercise as evaluated by the systolic time intervals in normal man. Am Heart J. 1973; 85(4): 227-236.

[38] Liang N, Nakamoto T, Mochizuki S, Matsukawa K. Differential contribution of central command to the cardiovascular responses during static exercise of ankle dorsal and plantar flexion in humans. J Appl Physiol. 2011; 110(9): 670-680.

[39] Ichinose M, Delliaux S, Watanabe K, Fujii N, Nishiyasu T. Evaluation of muscle metaboreflex function through graded reduction in forearm blood flow during rhythmic handgrip exercise in humans. Am J Physiol Heart Circ Physiol. 2011; 301(7): H609-H616.

[40] Louhevaara V, Smolander J, Aminoff T, Korhonen O, and Shen NY. Cardiorespiratory responses to fatiguing dynamic and isometric handgrip exercise. Eur J Appl Physiol. 2000; 82(6): 340-344.

[41] Iellamo F, Legramante JM, Raimondi G, Castrucci F, Damiani C et al. Effects of isokinetic, isotonic and isometric submaximal exercise on heart rate and blood pressure. Eur J Appl Physiol Occup Physiol. 1997; 75(2): 89-96.

[42] Chapman JH, Elliott PW. Cardiovascular effects of static and dynamic exercise. Eur J Appl Physiol Occup Physiol. 1988; 58(11): 152-157.

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Managerial Stress among Religious Workers: Case Study of the Seventh-day Adventist Christian Pastors in Singapore

Margihon Bayu Putra Kaumpungan

Faculty of Arts & Humanities, Asia-Pacific International University, Thailand

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*Corresponding author:
Margihon Bayu Putra Kaumpungan, Faculty of Arts & Humanities, Asia-Pacific International University, Thailand

E-mail:
bayu@apiu.edu

ABSTRACT

Introduction: While studies on occupational health risk among different professions is considerably extensive, such research for religious workers tends to be overlooked. This research is aimed to investigate work-related stress among Christian ministers in Singapore. The focus of the study is to investigate how church management work leads pastors to increased stress.

Methods: Due to the limited number of participants countrywide, a qualitative approach was chosen to investigate. Five selected Seventh-day Adventist pastors in Singapore were selected for the study. Each was interviewed separately, and their response was analyzed.

Result: The multidimensional nature of church management, conflict, inevitable responsibility, priority differences, and personalization have been shown to increase the stress level among all pastors.

Conclusion: Church management work leads to increased stress among pastors due to the nature of the work which is multidimensional, conflict-prone, and inevitable. All the pastors also see that the managerial task is not their main job yet it affects them in a personal way. Furthermore, the sociocultural aspect of Singapore which emphasizes professionalism and hard work, tends to push these pastors to an increased level of stress.

Keywords: Managerial Stress, Religious Workers, Seventh-day Adventist, Singapore, Stress

Introduction

There was a time when working as a clergyman such as a pastor was an ideal career. A career in which all ideal aspects of a profession are manifested. Pastors are often portrayed as the moral authority of the society. They are meant to promote all the good aspects of humanity such as love, unity, courage, and peace. In family life, the pastoral family often becomes a model of what an ideal family relationship may look. In work-life balances, pastor's office hours are flexible and they are not bound by the demanding corporate life. Also, pastoral work is often assumed to promote inner peace, because of the constant connection with the spiritual realm that provides tranquility.

A growing body of kinds of literature, however, has shown that pastors are struggling with health issues distinctive to the general population. Pastors in general have a greater struggle with lifestyle-related diseases such as obesity and hypertension [1], and stress-related illness [2]. Furthermore, the link between metabolic syndromes with stress in the Christian ministers' population has been established [3]. These findings provide initial evidence that pastoral work may not be as ideal as what is being perceived. Thus, the investigation over what are some of the work-related health problems that pastors face is important.

While extensive studies on work-related health problems in other occupations are available, such research among pastors is considerably limited, particularly in the context of Southeast Asia. This research is intended to fill the knowledge gap in understanding work-related health problems among pastors. The specific research focus of the study is on the mental health of pastors, particularly on the aspect of stress. The study looks at how church management work contributes to the stress of pastors. As one of the main activities of a pastor, managing the church and how it relates to stress has been relatively understudied. Therefore, narrowing the gap in understanding stress among this population not only provides additional knowledge on the topic of pastoral mental health issues, but occupational health in general.

Methodology

Case Study Approach

The study utilized the exploratory case study approach to examine pastors' experience in church management in Singapore. Since the research object as a phenomenon is highly affected by its immediate context, a naturalistic approach to capture the data in its real-life situation is important instead of the experimental method [4]. Furthermore, an exploratory approach to the case study was chosen since available data on the research population and context are considered as its initial stage. Therefore, exploring participants' experiences is appropriate for understanding their context [5].

Participants

The pastors that were selected are ministers who are serving in a Christian denomination known as the Seventh-day Adventist (SDA). From the population pool of 10 pastoral staff of The SDAs who are living in Singapore, five pastors representing 50% of the total population were purposively recruited. These pastors were selected because of their sharing of similar characteristics to ensure a stable sampling. These selection criteria include being an ordained minister of the SDA Church, having served in the full-time ministry for over 7 years, having a full employment status by the church, currently serving as the head pastor of their respective church in Singapore, and having been serving in Singapore for at least 3 years.

Research Locale

Singapore, as the research location, was intentionally selected for the study. Known to many as the economic miracle of Asia [6], Singapore defies the common challenges of its neighboring Southeast countries such as high corruption and heavy bureaucratic red tape to become one of the cleanest governments and wealthiest countries in the world.

Historically, due to a lack of natural resources, Singapore relies highly on its human capital [7]. Thus, creating a culture of highly skilled workers and a high standard of professional expectation for all kinds of professions. The meritocratic culture that has been built at the core of the national ideology pushes each Singaporean to place a special value on performing extraordinarily well. Furthermore, Singaporean values tend to place leadership positions with high expectations [8]. Leadership in the concept of many Singaporeans follows the concept of the founder of modern Singapore, Lee Kuan Yew who believes a strong, professional, and corruption-free leadership is a non-negotiable value for a successful nation [9]. Lastly, Singapore adopted a rather unique working culture compared to its neighboring countries. Singapore syncretized the work culture of both the Western world emphasizing efficiency and productivity, with the Asian high performance and hard work culture [10]. Such cultures affect the entire layer of society, including religious life. It is within this context; that the study would like to explore the experience of pastors in church management.

Data Collection

The researcher contacted the regional SDA church leadership in Singapore before any data collection process started. After approval was received from the Seventh-day Adventist Conference Administrative Committee in Singapore, the researcher contacted the pastor to participate in the research. During the recruitment stage, no pastors who were contacted expressed unwillingness to participate in the research. Once each participant consented to join, the researcher arranged an online interview session with each participant.

Before the interview session began, each participant received the information sheet informing the nature of the interview and the right of the participant to withdraw from the research at any time of their request. After the participant consented, the researcher asked 10 semi-structured questions to each participant, exploring their perspective on the managerial stress of ministry in depth. Each interview lasted on average between 60 to 90 minutes. After each interview, the researcher asked each participant if there were any matters that needed to be clarified, or if there were any concerns need to be addressed in the form of debriefing. No participants expressed any concern.

The interview was recorded digitally. Each participant gave their consent for the recording to be stored by the researcher in a secured file directory with limited access to the researcher. The recording then being transcribed for further analysis.

Data analysis

The transcribed manuscripts of each participant were analyzed with the aid of ATLAS.ti Web (Version 23.0-2022-06-15) [11]. The researcher read each manuscript repeatedly to analyses and identify in-depth data on the pastor's experience with managerial stress. Special attention to the consistent pattern of the data was utilized to establish generalization of knowledge [12]. Furthermore, the pattern of themes that are emerging in the transcribed manuscript is compiled systematically. Lastly, each theme that emerged were clarified and reclarified by eliminating semantics and synonym several times to maintain the validity of the data [13]. The pattern of the data went through repeated re-clarification of themes to ensure the data remained consistent.

Results

The interview was able to collect substantial information from participants in relation to the challenges they face in their managerial duties. After the interviews were transcribed from their audio format, 17.315 words were generated in total from all the participants. During the coding process, five themes emerged, representing the entire data of the interview. These themes are multidimensionality, conflict, unavoidable responsibility, priority differences, and personalization. Details of each theme are elaborated below.

Multidimensionality of Church Management

All the participants interviewed expressed a consistent description of what they considered managerial stress in pastoral ministry. The first recurring pattern identified in the manuscript is that the managerial work of pastors is multi-dimensional.

The first dimension of church management mentioned by participants is related to the multiple administrative duties that pastors need to perform all the time. These duties vary from managing members in their voluntary work in the church, managing church finances, chairing different meetings, and providing reports and paperwork, to purchasing equipment and supplies for the church. These are some of the descriptions mentioned:

> Pastor 1: Meetings on the regional level, specific ministry level, with the upper-level leaderships, then within the church, then some project things like that. Then also, administrative wise, dealing with things like the building, and the renovation, license, these things spoil, that things spoil.
>
> Pastor 2: Run the service, volunteers, make sure everyone doing what they need to be done, run the board, run the church board, attend (meetings), be involved in the church school board, make sure administratively all that we keep whatever records that we pour things, all these things.

Most of these pastors are the chairman of the board and committees of their church as well:

> Pastor 1: In church, I chair all the boards.
>
> Pastor 3: Yes, I am the chairman of the board and committees in my church.
>
> Pastor 4: Yes, I do chair the board of my church.

As a follow-up question, the researcher also asked all participants about the financial management of their respective churches. In which one participant provided the answer:

> Pastor 5: The budget, of course (Treasurer/Elder, does it) but after the initial church approval budget (meeting), the rest I manage it.

Conflict

The next theme that consistently appears throughout the interview is conflict. Pastors who participated in the interview expressed their struggle in administration due to the outcome of their decision, which may not be acceptable to their entire congregation. Decision-making is part of every organizational leadership role. However, distinctive to pastoral work is the relationship between the decision-maker and the recipient. Maintaining the clergyman's ideal of a compassionate person tends to create tension in pastors when they must make decisions, as some of them express themselves:

> Pastor 3: Making use of the participation of the people trying to make (other) people happy. Some people do not want to participate in church services and church activities, yet they would like to claim that they are very active members, so we need to convince them to take part in the life of the active part of the church.
>
> Pastor 5: I think church administration for me the most challenging I guess, (long pause) conflict. If you want me to rate, I will say the highest and probably the most stressful for me as a pastor is dealing with conflict.

Unavoidable Responsibility

The third theme being mentioned is that managerial work is not easy to ignore. The expectation of accomplishing these tasks is inevitable. Often, the performance of the pastor is measured through these managerial tasks. Further, even when a pastor may not have direct involvement with the task in church, their presence as a pastor is expected to be in the church.

> Pastor 5: So, I was there… I was in the office every single day. Because it was the requirement given to me. I think normally with whatever there is to do in church. Almost everything to do in the church…because everything revolves around the church so I was at the church every day. Every single day.

Ironically, another pastor mentioned that despite the expectation for pastors to be present in the Church, yet some members do not realize the extent of the work involved in some of the managerial duties as one of the pastors expressed it this way:

> Pastor 1: I think facilities management is the least admin work I enjoyed, then repair, maintenance, and renovation. The most unpleasant matter of it is the tedious part of it.

Priority Differences

All pastors expressed that church management they do as not their main role and duty as a pastor. Therefore, it distracts them from their main duty as a pastor and drains extra energy into their work.

Pastors do not see church management as unnecessary or not important. However, the amount of it had overtaken the main job of pastors brought stress to them. When participants were asked about their managerial work in the church, they described it in these answers:

> Pastor 4: I don't hate administration itself. I just hate over-administration. Just to be honest, useless reports, or repetitive. I am stressed not by filling it in but by my resentment of having to fill it in.

Some pastors, did however, express a clearer statement that managerial work is not something that they find pleasant in the ministry work:

> Pastor 1: I don't enjoy administrative work.
> Pastor 2: Not really (enjoying it), that is why I keep disappearing to do other stuff. I don't really care.

The extra energy and time exerted by the church management led to emotional tension. As a result, it produced stress in pastors. During the interview, significant non-verbal communication expression indicating stress was detected in the interview. When participants were asked about the stress caused by managerial work and its impact on their personal life, they spoke faster, and in a stronger tone. Verbally, their stress response was expressed in this way:

> Pastor 1: I don't hate administrative work, what I dislike about it is that it takes away time from doing what is more important.
> Pastor 4: Of course, you feel frustrated about doing all these things, where as a pastor there are many more meaningful things I should be doing.

Personalization

Lastly, participants expressed how managerial stress affected their personal lives. They expressed that the boundaries between professional and personal lives tend to be blurred. Thus, their challenges at work influence their lives after work as well. Furthermore, such tension often went unnoticed by their congregation. Such distortions are expressed in these ways by some participants:

> Pastor 1: I think members in general don't understand the broadness of the scope of the pastor's job.
> Pastor 4: Sometimes I honestly felt that it is affecting my life, and my personal life because I have to take, other extra time out of my personal time and family.

While all participants received the same list of the pre-set questions, the variation of their answers depended on the nature of their personality, communication skills, and worldview. At the end of all interviews, however, each of the pastors expressed their appreciation that the issue of is addressed in research. Such expression indicates that managerial stress did have an impact on the pastors' welfare regardless of their unique responses to the interview questions.

Discussion

The research captures the dynamics of church management for pastors and the mental health effect it creates for pastors. Pastoral ministry, as shown in the result, tends to be a "jack of all trades." Pastors play multiple roles for different types of needs of their members. From a management point of view, however, the level of authority of the pastor in each of these tasks seems to have various levels that tend to be too broad. On one side, a pastor is expected to exercise ultimate authority to execute a decision for the church, while on others, they must be on the receiving side of completing someone else decision. Such role confusion had been expressed by the participants to be tiring, frustrating, and sometimes unnecessary. Thus, the role confusion problem that led to stress in pastoral work discovered here replicates similar research from other studies [14, 15].

Another aspect of administrative work that is highlighted by the participants is the issue of conflict. From a purely administrative point of view, the decision-making process that involves people inevitably will bring conflict. However, in contrast with the corporate relationship between managers and subordinates, pastor's relationships with their members are multidimensional. Therefore, the decision-making process in pastoral work is not always a straightforward process. On one side, as the leader of the church, pastors must set a direction and exercise authority over the church and the congregation. Some of these decisions will create resistance among some of the members of the church. Yet, the decision must be carried over. However, on the other hand, pastors must juggle such an authoritative role with the pressure of a moral example of kindness and gentleness. Therefore, when it comes to conflict, these conflicts tend to cause personal emotional pressure and pain in pastors [16]. Furthermore, most pastors, by nature, are a people-oriented person [17]. When it comes to interpersonal relationships, they prioritize harmony and agreement. Therefore, conflict can be perceived as an emotional threat that increases the stress level among pastors.

The third aspect of administrative work that came out from the interview is the heavy number of administrative activities that pastors are involved. In almost all areas of church life, pastors are expected to provide some form of direction for the church. In other words, as a manager, pastors are expected to always be making decisions for the church. A constant, rapid decision-making in tasks has been shown to lead to decision fatigue [18, 19]. Decision fatigue has been defined as the inability of an individual to make an optimum decision due to the constant need for decision-

making over a short period [20]. The decision fatigue increased the stress level and frustration of these pastors.

Furthermore, as expressed by the participants in the result, many of the church managerial work done by the pastor tend to be underestimated or went unnoticed by members even though pastors spent a significant amount of time in it. Study indicates that effort-reward imbalances in pastoral work are associated with an increase in depression and anxiety problems [21]. Therefore, it is plausible to associate a similar impact to the situation of the pastors interviewed in the study. The unnoticed effort in the managerial work of pastors leads to mental health problems.

Lastly, as indicated in the interview, the work of pastors also often lacks boundaries between professional and private life. Pastoral work tends to have no office hours. Pastors are often expected to provide their services at any time the need arises, including during time that is often outside of typical office hours, including holidays. In many situations, as shown in the result, pastors need to be able to decide on a church-related task anytime, anywhere. Due to these multiple angles of pastoral works and demands enhanced by the unclear form of boundaries seems to put an additional pressure that causes distress in pastors. This finding again remains consistent with earlier studies [22]. Most pastors tend to be at the center of the church life. Therefore, there is a tendency to centralize all tasks and responsibilities related to the church towards the pastor as well. Since the research locale of the study is Singapore, the tendency of centralizing all responsibilities to the pastor needs to be analyzed from the perspective of its cultural context. Singapore had been considered as an economic miracle that reached prosperity within one period of leadership despite lacking in natural resources [23]. The success of Singapore had been credited towards the high emphasis in utilizing the most important asset the country possesses that is their human resources [24]. Since the emphasis on human resources had been fully integrated in Singaporean society, individual performance and professionalism had been in constant high expectation. This includes the performance of pastors in the church ministry. As a professional, pastors are expected to perform to the best of their capability in their role as religious professionals. Therefore, pastors are often being placed in a difficult situation to discern what is professional and what is pastoral.

As shown in the result, the pastor-centric tendencies of the church lead to pastors having to work extra to ensure the church is in working condition. Such exerted effort caused the pastor to lose energy and time for families and personal needs, thus leading to an increased stress level in the pastor. Another angle of theory that can be established from the study is how pastors perceived priorities in their ministries. Most pastors interviewed perceived that managerial work was not meant to be their main priorities and responsibilities. Therefore, pastors do not see it as the main platform on which they need to spend their energy. Instead, they are seeing administrative work as using up their main energy sources that are meant for other more important priorities. High reward task leads to an accelerated response when an individual need to select between multiple tasks to be completed [25]. For most pastors who are interviewed, administrative task tends to be associated with low to no reward, yet they need to complete them, nevertheless. The conflict between the obligations to complete the task with the low reward outcome likely leads to increased stress among them. From the perspective of occupational health, a healthier work-life balance is critical for the welfare of a worker, including their mental well-being. In pastoral work in Singapore, such balance tends to be at risk due to the high expectation of managerial duties that need to be performed by the pastor.

Since this study is considered a pilot study, it gives an opportunity for further exploration in research to address and discover a potential solution for the problem. As shown by the study, the pastor-centric nature of work in the church tends to overwhelm the pastor with managerial work. Perhaps the church needs to explore employment arrangements for a full-time administrator for the management of the church to reduce the pastor's responsibility in managerial duties. When organizational and congregational support is received by the pastor in their ministry, a significant reduction in fatigue can be seen among the pastors [26].

Lastly, the importance of having a disengaged connection with work is also critical in the reduction of stress in the workplace as well. There is a need for a break from the routine that causes stress among pastors. Studies have shown the protective benefits of disengagement from work toward pastors' mental and spiritual health among non-SDA ministers [27]. The present research had several limitations. As described earlier, selecting Singapore as the research locale provides several advantages for the data collection and the knowledge produced by it. Socioeconomic status has a significant impact on determining the health status of clergymen [28]. Therefore, data obtained from this study still needs to be compared to similar studies from the nearby region. Second, due to the nature of pastoral service in the SDA Church, the study only manages to interview male pastors. However, gender differences have been shown to impact the mental health status of pastors differently [29].

While quantitative research will provide further knowledge into the present research, the lack of enough population for a statistically significant result likely will halt the process. There were only 10 available participants countrywide. Thus, making qualitative approach is the best way to investigate. To overcome this, perhaps SDA pastors from the surrounding region

such as Malaysia, Indonesia, Thailand, and the Philippines should be included to fit the sampling requirements in future research.

Conclusion

For these pastors who were interviewed, church management had been one of the areas of pastoral ministry that tended to drain up their energy and bring stressful situations to their ministry. The combination of overwhelming tasks in managing the church, the potential conflict that resulted from their decision, and the result of the work that tends to be unnoticed lest appreciated by members makes church management a source of intense work-related stress. In the context of Singapore, in which higher pressure to perform is embedded in the culture, the task related to the managerial work of pastors brings even greater stress to these pastors. Task accomplishments, which often come with professionalism, were fully carried out by pastors on their own.

Several modifications to pastoral work need to be pursued to reduce the potential harm to administrative work in pastoral ministry. The decentralization of the task distribution away from pastors perhaps should be considered the most critical change. Alternatively, removing the managerial task of a pastor to a hired professional in management may be another radical idea that the church may need to consider.

References

[1] Proeschold-Bell RJ, LeGrand S. High Rates of Obesity and Chronic Disease Among United Methodist Clergy. Obesity [Internet]. 2010 Sep 1;18(9):1867–70. Available from: https://doi.org/10.1038/oby.2010.102

[2] Proeschold-Bell RJ, Miles A, Toth M, Adams CM, Smith BW, Toole D. Using Effort-Reward Imbalance Theory to Understand High Rates of Depression and Anxiety Among Clergy. The Journal of Primary Prevention [Internet]. 2013 Aug 22;34(6):439–53. Available from: https://doi.org/10.1007/s10935-013-0321-4

[3] Smith TW, Eagle DE, Proeschold-Bell RJ. Prospective Associations Between Depressive Symptoms and the Metabolic Syndrome: the Spirited Life Study of Methodist Pastors in North Carolina. Annals of Behavioral Medicine [Internet]. 2017 Feb 16;51(4):610–9. Available from: https://doi.org/10.1007/s12160-017-9883-3

[4] Crowe S, Cresswell K, Robertson A, Huby G, Avery AJ, Sheikh A. The case study approach. BMC Medical Research Methodology [Internet]. 2011 Jun 27;11(1). Available from: https://doi.org/10.1186/1471-2288-11-100

[5] Lesa R. Personal Experience of Using Case Study for A Doctorate. Kai Tiaki Nursing Research. 2019;10(1):68–70.

[6] Holloway R. Singapore—An Asian economic miracle. Intereconomics [Internet]. 1971 Oct 1;6(10):317–8. Available from: https://doi.org/10.1007/bf02929133

[7] Osman-Gani AM. Human Capital Development in Singapore: An Analysis of National Policy Perspectives. Advances in Developing Human Resources [Internet]. 2004 Aug 1;6(3):276–87. Available from: https://doi.org/10.1177/1523422304266074

[8] Low KCP. Types of Singapore Corporate Culture. Social Science Research Network [Internet]. 2011;2011(2):11–49. Available from: https://ssrn.com/abstract=1883436

[9] Lee KY. The Singapore Story: Memoirs of Lee Kuan Yew. Marshall avendish International Asia Pte Ltd; 2012.

[10] Leong FTL, Huang JH, Mak S. Protestant Work Ethic, Confucian Values, and Work-Related Attitudes in Singapore. Journal of Career Assessment [Internet]. 2013 Aug 5;22(2):304–16. Available from: https://doi.org/10.1177/1069072713493985

[11] ATLAS.ti Scientific Software Development GmbH [Internet]. [ATLAS.ti Web, v23.0]. 2022. Available from: https://atlasti.com/

[12] Baskarada S. Qualitative Case Study Guidelines. The Qualitative Report [Internet]. 2013 Nov 1; Available from: https://doi.org/10.46743/2160-3715/2014.1008

[13] Rashid Y, Rashid A, Warraich MS, Sabir S, Waseem A. Case Study Method: A Step-by-Step Guide for Business Researchers. International Journal of Qualitative Methods [Internet]. 2019 Jan 1; 18:160940691986242. Available from: https://doi.org/10.1177/1609406919862424

[14] Faucett JM, Corwyn RF, Poling TH. Clergy Role Stress: Interactive Effects of Role Ambiguity and Role Conflict on Intrinsic Job Satisfaction. Pastoral Psychology [Internet]. 2012 Sep 5;62(3):291–304. Available from: https://doi.org/10.1007/s11089-012-0490-8

[15] Frederick TE, Thai Y, Dunbar S, Ardito R, Eichler K, Kidd K, et al. The Effects of Role Differentiation Among Clergy: Impact on Pastoral Burnout and Job Satisfaction. Pastoral Psychology [Internet]. 2023 Jan 6;72(1):121–42. Available from: https://doi.org/10.1007/s11089-022-01052-w

[16] Henard W. Conflict in the Small and Medium Sized Church. Great Commission Research Journal. 2017;8(2):223–39.

[17] Stevens J. Pastors and Volunteers in Small to Medium Sized Churches: The Traits that a Pastor Needs for Leading Volunteers [Seniors Honor Thesis]. Liberty University; 2012.

[18] Pignatiello GA, Martin RM, Hickman RL. Decision fatigue: A conceptual analysis. Journal of Health Psychology [Internet]. 2020 Jan 1;25(1):123–35. Available from: https://doi.org/10.1177/1359105318763510

[19] Moorhouse A. Decision fatigue: less is more when making choices with patients. British Journal of General Practice [Internet]. 2020 Jul 30;70(697):399. Available from: https://doi.org/10.3399/bjgp20x711989

[20] Natal G, Saltzman B. Decisions, decisions, decisions: decision fatigue in academic librarianship. The Journal of Academic Librarianship [Internet]. 2022 Jan 1;48(1):102476. Available from: https://doi.org/10.1016/j.acalib.2021.102476

[21] Proeschold-Bell RJ, Miles A, Toth M, Adams CM, Smith BW, Toole D. Using Effort-Reward Imbalance Theory to Understand High Rates of Depression and Anxiety Among Clergy. The Journal of Primary Prevention [Internet]. 2013 Aug 22;34(6):439–53. Available from: https://doi.org/10.1007/s10935-013-0321-4

[22] Proeschold-Bell RJ, McDevitt P. An Overview of the History and Current Status of Clergy Health. Journal of Prevention & Intervention in the Community [Internet]. 2012 Jul 1;40(3):177–9. Available from: https://doi.org/10.1080/10852352.2012.680407

[23] Lee KY. The Singapore Story: Memoirs of Lee Kuan Yew. Marshall Cavendish International Asia Pte Ltd; 2012.

[24] Yusuf S. Building Human Capital [Internet]. World Bank, Washington, DC eBooks. 2020. Available from: https://doi.org/10.1596/34206

[25] Rieger T, Mittelstädt V, Dignath D, Kiesel A. Investigating limits of task prioritization in dual-tasking: evidence from the prioritized processing and the psychological refractory period paradigms. Psychological Research-psychologische Forschung [Internet]. 2019 Sep 24; Available from: https://doi.org/10.1007/s00426-019-01250-x

[26] Village A, Francis LJ. Wellbeing and perceptions of receiving support among Church of England clergy during the 2020 Covid-19 pandemic. Mental Health, Religion & Culture [Internet]. 2021 May 4;1–15. Available from: https://doi.org/10.1080/13674676.2021.1906214

[27] Hough H, Proeschold-Bell RJ, Liu X, Weisner CC, Turner EL, Yao J. Relationships between Sabbath Observance and Mental, Physical, and Spiritual Health in Clergy. Pastoral Psychology [Internet]. 2018 Oct 8;68(2):171–93. Available from: https://doi.org/10.1007/s11089-018-0838-9

[28] Case A, Eagle DE, Yao J, Proeschold-Bell RJ. Disentangling Race and Socioeconomic Status in Health Disparities Research: an Examination of Black and White Clergy. Journal of Racial and Ethnic Health Disparities [Internet]. 2017 Dec 21;5(5):1014–22. Available from: https://doi.org/10.1007/s40615-017-0449-7

[29] Lutz JS, Eagle DE. Social Networks, Support, and Depressive Symptoms: Gender Differences among Clergy. Socius [Internet]. 2019 Jan 1; 5:237802311987382. Available from: https://doi.org/10.1177/2378023119873821

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Oral Probiotic: A Role in Oral Cavity

Dolyawee Chaowadee

Singapore Intercultural School, South Jakarta, Indonesia, 12440

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***Corresponding author**:
Dolyawee Chaowadee, Singapore Intercultural School, South Jakarta, Indonesia, 12440

E-mail:
dolyawee.ch@gmail.com

ABSTRACT

Probiotics are live microorganisms promoted with claims that they provide health benefits when consumed. It has attracted the attention of both professionals and patients in recent decades. The purpose of this paper is to describe the role and beneficial effects of probiotics in the prevention and treatment of oral diseases. Probiotics can produce antimicrobials, compete for cell adhesion sites, modulate the immune system, and perform other mechanisms that aid in the prevention and treatment of dental caries, periodontitis, and many other oral health diseases, according to the findings. Probiotics may be a valuable adjunct to the conventional treatment that causes problems. However, there are still questions about the best bacterial strain combination for each disease, appropriate dosage, and potential side effects. Therefore, further studies are required.

Keywords: Bacterial strain, Microorganisms, Oral diseases, Probiotics

Introduction

For centuries, dentists have struggled with oral problems. It is widely recognized that an individual's age, physical well-being, nutritional condition, lifestyle, and—most importantly—the variety of resident bacteria all have a significant impact on oral health. The oral cavity is a dynamic ecosystem with constant environmental change and commensal bacterial interaction, which helps to prevent the colonization of pathogenic microorganisms. In addition, the oral microbiota is heterogeneous and diverse. Its imbalance may result in the development of a number of significant diseases, including dental caries, periodontitis, halitosis, candidiasis, and gingivitis. Adopting mechanical techniques to remove bacterial plaque and administering antimicrobial medication therapy are two common conventional treatments for these oral diseases [1]. However, recently there is a development of resistance regarding the use of these antibiotics [1]. Therefore, it's time to shift the paradigm of treatment from eliminating the pathogenic bacteria to altering the bacterial ecology by using probiotics to avoid the possibility of returning back to pre-antibiotic dark ages [2]. Probiotics are beneficial bacteria that naturally live in the human body, especially in the oral cavity. It helps to maintain the oral health through interaction with the oral microbiome, contributing to healthy microbial equilibrium and antagonistic to the harmful bacteria [3, 4]. The introduction of probiotics is interesting to global professionals because it provides an effective alternative to the conventional therapeutic way and also free from concerns of developing resistance because probiotics are counterparts of antibiotics. Furthermore, they are the body's own residential flora hence are most easily adapted to host [5].

This review is written with the purpose to update and summarize the currently available data regarding the characteristics, types, mechanisms of probiotics which aid in the treatment of several diseases, along with their offered applications.

Characteristics of probiotics

'Probiotics' is a Greek term which translates as 'for life.' They are hence microorganisms that have been established to exert beneficial impacts on both human and animal health. In addition, probiotics are referred to as 'live microorganisms that, when administered in adequate amounts, confer a health benefit to the host' by The Food and Agricultural Organization of the United Nations (FAO) and The World Health Organization (WHO). This affirmed with the prior interpretation of the Greek's probiotics term. Even though probiotics have just gained a massive amount of interest recently, some professionals have seen the prospects since 1994 as WHO stated that they are the next most important

immune defense system when commonly prescribed antibiotics are rendered useless by antibiotic resistance. Therefore, it can be simply summarized that probiotics are non-pathogenic living microorganisms, principally bacteria, that are safe for consumption, which are used to prevent various medical conditions. However, to be called a probiotic, a bacterial strain must be fully characterized. According to the recommendation from the FAO and the WHO, probiotics bacterial strains are characterized by their spectrum of resistance to antibiotics and hemolytic activities, their capacity to produce toxins, their infectious power in immunocompromised animal models and their side effects in humans. Most commonly they are bacteria. Some of their species are (1) Lactic acid producing bacteria (LAB), including *Lactobacillus*, *Bifidobacterium*, and *Streptococcus*; (2) Non-LAB species, including Bacillus and Propionibacterium; (3) Non-pathogenic yeasts, including *Saccharomyces*; and (4) Non spore forming and non-flagellated rod or *Coccobacilli*.[6]

Types of probiotics

The genera *Lactobacillus* and *Bifidobacterium* contain the majority of the probiotic strains. In oral biofilm, *lactobacillus* is regarded as a typical component. It accounts for approximately 1%. The *Lactobacillus* species from which probiotic strains have been isolated include *L. acidophilus acidophilus, Lactobacillus johnsonii, Lactobacillus casei, Lactobacillus rhamnosus, Lactobacillus gasseri*, and *Lactobacillus reuteri*. For *Bifidobacterium*, they are only marginally generated in oral biofilm. The strains include *B. bifidum, B. longum*, and *B. infantis* [7, 8] At the present, although there is scarce amount of information regarding the indigenous probiotics to evidence their benefits, these strains are rarely involved in human infections and form the majority of probiotics in general. In fact, some studies also show that these bacteria have a symbiotic relationship with human beings. For instance, Koll-Klais et al. reported that healthy oral cavity was populated with *Lactobacillus gasseri* and *Lactobacillus fermentum*, whereas periodontitis patients were free of these two species but populated with *Lactobacillus plantarum* [9].

Mechanism of action of probiotics

Several mechanisms have been proposed regarding the action of probiotics which help in competing with the oral pathogens and providing health benefits to the host. Firstly, the probiotics compete with the pathogens for the adhesion sites on mucosa. This prevents the pathogen from adhering to the host tissues. In fact, the adhering ability is one of the characteristics that probiotic candidates should have as it should be able to successfully establish itself in the oral biofilm to exert health benefits. Some examples of bacterial strains that are reported to possess strong binding activity (more than 20%) are *L. rhamnosus* and *L. paracasei*. After the probiotics have adhered and colonized on the oral surface, they compete with oral pathogens for nutrients and growth factors, and also produce antimicrobial compounds, including organic acids, hydrogen peroxide, carbon peroxide, diacetyl, and low molecular weight antimicrobial substances, bacteriocins, and adhesion inhibitors [3]. These substances inhibit the growth of pathogens, which further help in decreasing the possibility of disease initiation. Furthermore, other health-beneficial mechanisms of probiotics are enhancement of the non-specific and specific immune response of the host, degradation of toxins, and modification of the surrounding environment such as pH and/or oxidation and reduction potential which may compromise the establishing ability of pathogens [6].

Probiotics and oral health diseases

The advancement in dentistry and scientific fields has led to a paradigm shift away from treating dental diseases by targeting specific oral pathogens towards an ecological and microbial community-based approach [10]. Studies have shown that the oral cavity is a habitat for a large diversity of microorganisms, dominantly bacteria, which are all associated with oral infections. The balance between microflora and the host is significant in order to maintain an appropriate oral health. A shift in the balance between them can result in several diseases of the oral structures such as dental caries and periodontitis [11]. Therefore, probiotics, which contribute to an appropriate balance in microflora, can play a vital role in the prevention and treatment of oral diseases when consumed regularly.

Probiotics and dental caries

Dental caries is commonly known as cavities or tooth decay. It can be generally defined as a localized chemical dissolution of the tooth surface resulting from metabolic events in a biofilm (dental plaque) covering the affected area. It leads to many painful symptoms such as toothache, tooth sensitivity, staining on the tooth, etc [12]. Elements that must be present for disease initiation and progression are host, bacteria, and nutrients as they are required to foment the production of organic acids and the subsequent demineralization activity. The removal of any element leads to the interception of the disease process [5]. However, all the elements are present in the oral cavity most of the time, therefore there is a high possibility of dental caries formation. In case of dental caries, there is an increase in acidogenic and acid tolerating species such as *lactobacilli*, and especially, *streptococcus mutans* [2]. Studies have shown that elevated levels of *S.mutans* are strongly associated with increased risk of dental caries [13]. Hence, many recents prevention strategies are focusing on inhibiting the proliferation of *S.mutans* and its adherence to the oral surfaces as it is capable of producing acids from carbohydrates fermentation.

These acids can demineralize and destroy the dental tissues. According to an established global dental practice, the treatment and control of dental caries can be done by mechanically removing the carious lesion along with using antimicrobial. However, according to the stated issue of increasing resistance strains and the arise of positive probiotic studies, probiotics have been proposed as an adjunct method to dental caries management strategies as they adhere to oral tissues, and prevent the colonization of caries pathogens and formation of pathogenic biofilm. In addition, some of them are also capable of producing inhibitors of cell adhesion and antibacterial agents, and consuming nutrients before caries pathogens can further use them [1] (Figure1).

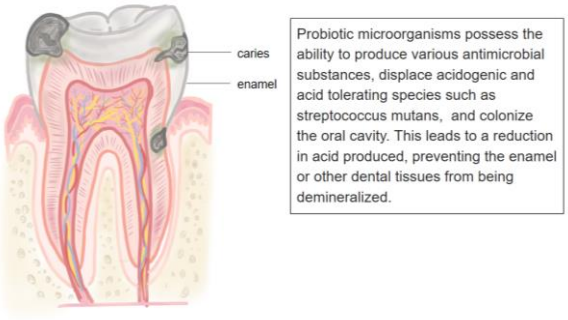

Figure 1 Carious lesions resulting from the dissolution of minerals in enamel and dentin by acids produced during the metabolism of food residues by microorganisms colonizing tooth surfaces

Probiotics and periodontitis

Periodontal diseases, including periodontitis, are a group of inflammatory pathologies of the periodontium that lead to teeth loss principally due to dysregulated, immune-mediated destruction of the periodontal ligaments and tooth-supporting structures [16]. They are the most common inflammatory destructive conditions that negatively affect many people. According to WHO, 15-20% of middle-aged adults encounter tooth loss due to severe periodontal diseases. The disease is initiated by components of the plaque which develops on the hard surface adjoining the soft tissues that support periodontium. Treatment is needed as soon as possible because the disease can further extend to the gingiva or to deeper supporting structures leading to the destruction of the periodontal ligament and the alveolar bone in the worst case [12]. In the disease development, there is an increase in obligate anaerobic and proteolytic bacteria which might be reduced by the administration of probiotics. In fact, three factors that determine whether disease will develop in a subject are a susceptible host, the reduction or absence of beneficial bacteria, and the presence of pathogenic species such as *Porphyromonas gingivalis*, *Treponema denticola*, *Tannerella forsythia*, *A. actinomycetemcomitans*, *Bacteroides sp.*, *Actinomyces sp.*, *Staphylococcus intermedius*, and *Candida albicans* [5, 17]. According to studies, the disease could be inhibited via probiotics by lowering the salivary pH and producing antioxidants that utilize the free electrons required to mineralize plaque [3]. To be simple, the probiotics will alter the oral microbial ecology.

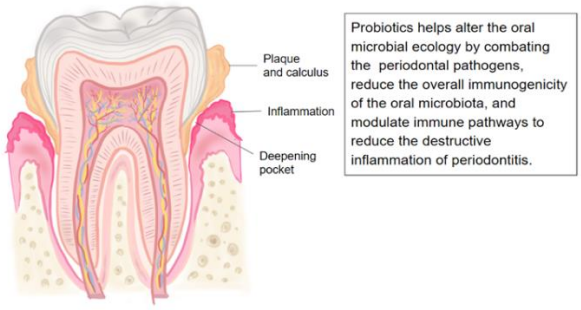

Figure 2 Bacterial plaque formation around the tooth and inflammation of bacterially-infected tissue leads to periodontitis.

They will firstly combat dysbiosis by competitive inhibition of periodontal pathogens and reduce the overall immunogenicity of the oral microbiota, and secondly modulate active disease-associated immune pathways to reduce the destructive inflammation of periodontitis, leading to immune homeostasis that could be maintained by the host in the long term.[17] Even though the conventional treatment of periodontitis, which involves the mechanical removal of the subgingival plaque, is more popular among professionals, removing the bacterial plaque in low-access sites can be difficult. This could lead to the relapse of periodontitis due to the huge amount of remaining bacteria left in the plaque [18]. As a result, probiotics are required to aid in this process (Figure 2).

Table 1. List of probiotics studied for limiting the progress of oral diseases and their causative pathogens

Disease	Causative agent	Therapeutic probiotics	Results	References
Dental caries	*Streptococci mutans, Streptococcus sobrinus Bifidobacteria nonmutans Streptococci, Actinomyces spp., Propionibacterium spp., Veillonella spp., and Atopobium spp, Fusobacterium nucleatum, and Prevotella intermedia*	*L. reuteri,* *L. rhamnosus, and Bifidobacterium*	Administration of *L. reuteri*, in lozenge, straw, and tablet forms, *L. rhamnosus* in milk, Bifidobacterium in yogurt have shown a reduction in salivary *S. mutans* levels	Parihar, Anuj Singh, and Vartika Katoch (2015) [5]
		L. rhamnosus GG	*L. rhamnosus* GG has the highest adhesion value and inhibits Streptococcus by producing antimicrobial components such as organic acid, hydrogen peroxide, carbon peroxide, and diacetyl bacteriocins.	Piqué, Berlanga, and Miñana-Galbis (2019) [14]
		Streptococcus dentisani	Probiotic *Streptococcal species*, *Streptococcus dentisani*, isolated from dental plaque of caries-free individuals. The strain was shown to inhibit the growth of major oral pathogens like *S. mutans*, *Fusobacterium nucleatum*, and *Prevotella intermedia* through the production of bacteriocins, and also buffers acidic pH of the oral cavity.	López-López et al. (2017) [15]

Disease	Causative agent	Therapeutic probiotics	Results	References
Periodontitis	*Porphyromonasgingivalis, Treponema denticola, Tannerella forsythia, Aggregatibacter actinomycetemcomitans, Bacteroides sp., Actinomyces sp., Staphylococcus intermedius and C. albicans*	*Lactobacillus rhamnosus* GG (LGG), *Bifidobacterium animalis subspecies lactis Bb-12* (BB-12)	The short-term consumption of *Lactobacillus rhamnosus GG* (LGG) and *Bifidobacterium animalis subspecies lactis Bb-12* (BB-12) reduces the amount of plaque and it is clinically relevant for the reduction of gingival inflammation.	Toiviainen et al. (2015) [20]
		L. salivarius *L. reuteri*	Administration of mouthwash using selected strains of *L. reuteri* or tablets containing 6.7 × 108 colony forming units of L. salivarius and Xylitol (280 mg/tablet) reduced the accumulation of gingivitis and plaque. [(7)]	Reddy, Swapna, and others (2011)[7]
		L. casei 37 *L. salivarius TI 2711*	When compared to a placebo, an *L. salivarius* WB21-containing tablet demonstrated insignificant differences in pocket probing depth and bleeding on probing indices. L. casei 37 can reduce the number of most common periodontal pathogens, and L. salivarius TI 2711 inhibits P. gingivalis when given for 4 or 8 weeks.	Grajek, Olejnik, and others (2005) [19]

Applications of probiotics

Probiotics could be provided in products in different ways, such as inoculants in dairy products and prebiotic fibers, concentrated culture in food and beverages, and dietary supplements [21]. The supplement is an easy and popular way. However, for the best results in the prevention or treatment of dental diseases, specifically targeted applications with slow release of probiotics may be required. Some carriers available currently are capsule and liquid form, chewing gum, and tablet [5]. According to the studies that are currently available, chewing gum and tablets have more support than capsules and liquids. A tablet containing a probiotic mix of Acilact and Bifidumbacterin was developed by Grudianov et al. in 2002. The product helps to normalize the micro flora and prevent gingivitis and periodontitis. In addition, *L. reuteri* Prodentis chewing gum has recently been invented for twice-daily consumption. This gum can regulate *S. mutans* levels and aid in caries prophylaxis.[5] However, despite these inventions, there are still no studies that define the most suitable means of delivery and dosages of probiotics for various oral health purposes. Furthermore, the fact that a probiotic can be made from a single or multiple combination strains makes determining the best treatment strains even more difficult. Nevertheless, there are some ideal requirements of probiotic products that the researcher can rely on in order to identify the suitable strains. These criteria stated that the product should show the beneficial effect in host animals, should be non-pathogenic and nontoxic, should be capable of surviving and metabolizing in the oral environment, and finally, should remain viable under storage for duration [6].

Conclusion

Probiotics are living microorganisms that are made out of single or multiple strains. They are used to treat various oral health problems through their direct and indirect mechanisms. They offer an advantage to the human oral ecosystem without any other systemic harmful effects or drug resistance. Probiotics bring the advancement toward the research area of oral medicine, the examination of the close relationships between food and oral health. In order to administer the probiotics, health professionals are in an ideal position to help and guide their patients toward appropriate therapeutic uses of probiotics that deliver the desired beneficial health effects [5]. However, probiotics are still unaccepted by some professionals nowadays due to insufficient amount of supporting substantial evidence. Therefore, further clinical studies are required to prove their role in oral health, and to select the best-suited probiotic for each issue. Future research should focus on obtaining substantial data from blind, large-scale, long-term, randomized, placebo-controlled clinical trials studies with the emphasis on strain efficacy, dose effects, and delivery vehicles to determine the most effective probiotic strain combination that are accepted by different age groups and conditions.

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References

[1] Saïz P, Taveira N, Alves R. Probiotics in oral health and disease: a systematic review. Applied Sciences. 2021; 11(17): 8070. DOI: 10.3390/app11178070

[2] Kumar YP, Juhi M, Unaidul H, Neelofar. Role of probiotics in oral health: a review. International Journal of Dental and Health Sciences. 2016.

[3] Alharith, D, Alhokair R, Zakri N, Alshaqha N, Almutairi M, Alamri M. An overview of probiotic use in dentistry: a literature review. Int J Med Dev Ctries. 2021; 5(1): 341-346. DOI:10.24911/IJMDC.51-1602155690

[4] Mahasneh SA, Mahasneh AM. Probiotics: a promising role in dental health. Dentistry Journal. 2017; 5(4): 26. DOI: 10.3390/dj5040026

[5] Parihar AS, Katoch V. Probiotics in oral health: a review. Journal of Advanced Medical and Dental Sciences Research. 2015; 3(1): 57.

[6] Babaji P, Keswani K, Lau H, Lau M, Sharma N, Punga R. Role of probiotics in oral health: A review of the literature. Journal of Education and Ethics in Dentistry. 2012; 2(2): 52. DOI: 10.4103/0974-7761.121256

[7] Reddy RS, Swapna LA, Ramesh T, Singh TR, Vijayalaxmi N, Lavanya R. Bacteria in oral health-probiotics and prebiotics a review. Int J Biol Med Res. 2011; 2(4): 1226-1233.

[8] Fierro-Monti C, Aguayo-Saldías C, Lillo-Climent F, Riveros-Figueroa F. Role of probiotics as bacteriotherapy in dentistry: a literature review. 2018. DOI: 10.22592/o2017n30a2

[9] Kõll-Klais P, Mändar R, Leibur E, Marcotte H, Hammarström L, Mikelsaar M. Oral lactobacilli in chronic periodontitis and periodontal health: species composition and antimicrobial activity. Oral microbiology and Immunology. 2005; 20(6): 354-361. DOI: 10.1111/j.1399-302X.2005.00239. x.

[10] Marsh PD. Are dental diseases examples of ecological catastrophes? Microbiology. 2003; 149(2): 279-294. DOI: 10.1099/mic.0.26082-0

[11] Allaker RP, Ian Douglas CW. Non-conventional therapeutics for oral infections. Virulence 6.3 (2015): 196-207. DOI: 10.4161/21505594.2014.983783

[12] Chugh P, et al. A critical appraisal of the effects of probiotics on oral health. Journal of Functional Foods. 2020; 70: 103985. DOI: 10.1016/j.jff.2020.103985

[13] Stamatova I, Meurman JH. Probiotics: health benefits in the mouth. American Journal of Dentistry. 2009; 22(6): 329-338.

[14] Piqué N, Berlanga M, Miñana-Galbis D. Health benefits of heat-killed (Tyndallized) probiotics: an overview. International Journal of Molecular Sciences. 2019; 20(10): 2534. DOI: 10.3390/ijms20102534

[15] López-López A, Camelo-Castillo A, Ferrer MD, Simon-Soro Á, Mira A. Health-associated niche inhabitants as oral probiotics: the case of Streptococcus dentisani. Frontiers in Microbiology. 2017; 8: 379. DOI: 10.3389/fmicb.2017.00379

[16] Allaker RP, Stephen AS. Use of probiotics and oral health. Current Oral Health Reports. 2017; 4(4): 309-318. DOI: 10.1007/s40496-017-0159-6

[17] Fernando L, Arias-Herrera S, Caffesse R. Relationship between diabetes and periodontal infection. World Journal of Diabetes. 2015; 6(7): 927-935. DOI: 10.4239/wjd. v6. i7.927

[18] Willis JR, Gabaldón T. The human oral microbiome in health and disease: from sequences to ecosystems. Microorganisms. 2020; 8(2): 308. DOI: 10.3390/microorganisms8020308

[19] Grajek W, Olejnik A, Sip A. Probiotics, prebiotics and antioxidants as functional foods. Acta Biochimica Polonica. 2005; 52(3): 665-671.

[20] Toiviainen A, Jalasvuori H, Lahti E, Gursoy U, Salminen S, Fontana M, et al. Impact of orally administered lozenges with Lactobacillus rhamnosus GG and Bifidobacterium animalis subsp. lactis BB-12 on the number of salivary mutans streptococci, amount of plaque, gingival inflammation and the oral microbiome in healthy adults. Clinical Oral Investigations 2015; 19(1): 77-83. DOI: 10.1007/s00784-014-1221-6

[21] Teughels W, Loozen G, Quirynen M. Do probiotics offer opportunities to manipulate the periodontal oral microbiota? Journal of Clinical Periodontology. 2011; 38: 159-177. DOI: 10.1111/j.1600-051X.2010. 01665.x