ISSN 2386-1665
ISSN 2792- 100X
(electronic)

CINEC CAMPUS
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CINEC Academic Journal

Volume 5 Issue II 2022

CONTENTS

1. Analysis of Antibiotic Prescription Patterns at Community Pharmacy Outlets; a Multi-Centered Study.
2. Analysis of dispensing pattern of OTC drugs in community pharmacy outlets, Sri Lankan perspectives; a pilot study.
3. Analysis of Knowledge, Usage and the Practice of Total Body Care Cosmetic Products in Western Province; Sri Lanka.
4. Assessment of Opinion and Awareness of the Constuction Industry on Suitability of M Sand as a Replacement to River Sand.
5. Evaluation of Practice on Self-Medication among Allied Health Science Undergraduates of Sri Lanka. Therapeutic and Toxicity Implications.
6. Optimizing Cement Quarry Dust Ratio in Concrete Asphalt Using for Industrial Purposes.
7. Phytochemical Analysis and Evaluation of In-Vitro Antioxidant Activity of Bark extracts from Madhuca longifolia (Madhu) and Ficus racemosa (Attikka) Grown in Sri Lanla.
8. Prevalance of primary dysmenorrhea and its influence on the daily activities of undegraduate female students in Colombo District, Sri Lanka.
9. Sociological and psychological perspective on spread of COVID 19 Virus: A study on philosophical paradigms.
10. Use of Concrete Waste from Industries as an Alternative Material for the Permeable Concrete Production.

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CINEC ACADEMIC JOURNAL

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Information to the subscribers and notes to the authors and contributors appear on the back page of the journal
ISSN 2386-1665
ISSN 2792-100X (electronic)

Printed by Infinity Printing Solutions Lanka

ISSN 2386-1665 ISSN 2792-100X

CINEC Academic Journal
Volume V Issue II 2022

01. Analysis of Antibiotic Prescription Patterns at Community Pharmacy Outlets; a Multi-Centered Study…….....01
Bandara P.M., Malhamiarachchige O., Mendis P., Weerakondaarachchi Y.D., Weligalle P.M., De Silva H.H.V.K.N., Kumari S.B.H.P.

02. Analysis of dispensing pattern of OTC drugs in community pharmacy outlets, Sri Lankan perspectives; a pilot study……...06
Kangara K.M.T.D.B., Senanayake S.D., Siriwardhana A.K., Maanisha N.W.A.N., Rathnasekara G.A.J., De Silva H.H.V.K.N., Rajapaksha R.G.W.D.B.

03. Analysis of Knowledge, Usage and the Practice of Total Body Care Cosmetic Products in Western Province; Sri Lanka…..……...…….....11
Hettihewa L.M., Yasendri K.G.I.M.

04. Assessment of Opinion and Awareness of the Construction Industry on Suitability of M Sand as a Replacement to River Sand...…….....18
Raheem M.S.M.S., Walpita S. C.

05. Evaluation of Practice on Self-Medication among Allied Health Science Undergraduates of Sri Lanka, Therapeutic and Toxicity Implications……...23
Srilal T.L.I. Hettihewa S.K. Perera K.L.C ., Chamara B.A.D.E., Amarasinghe W.K., Ariyadasa M.A.C.T., Masimbula H.W., De Silva H.H.V.K.N., Kumari S.B.H.P.

06. Optimizing Cement Quarry Dust Ratio in Concrete Asphalt Using for Industrial Purposes…….....30
De Silva D.H.J.M.V.R., Udayakumara G.

07. Phytochemical Analysis and Evaluation of In-Vitro Antioxidant Activity of Bark Extracts from Madhuca longifolia (Madhu) and Ficus racemosa (Attikka) Grown in Sri Lanka…….....39
Hettihewa S.K., Ruwanpathirana C.M., Panangalage P.

08. Prevalence of primary dysmenorrhea and its influence on the daily activities of undergraduate female students in Colombo District, Sri Lanka…….....45
Madampe S.N., Weerasooriya M.S., Lakshika W.A.C., Kariyawasam S.D.R., Fernandopulle R.C., Silva S.P.S.M.

09. Sociological and psychological perspective on spread of COVID 19 Virus: A study on philosophical paradigms……52
Kurukulaarachchi V.K., Siriwardhana H.A., Wesley J.P.

10. Use of Concrete Waste from Industries as an Alternative Material for the Permeable Concrete Production……...61
Manuwansha B.A.S.R., Sugandika T.A.N.

Original Article

Analysis of Antibiotic Prescription Patterns at Community Pharmacy Outlets; A Multi-Centered Study

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Abstract

This study aimed to analyze the types of prescribed antibiotics, frequency of usage, and age-based prescription patterns in a selected population. This study was granted ethical clearance and data were collected from Kottawa, Kalubowila, and Mawanella. Prescriptions were collected from patients after obtaining informed consent. Results showed that 41% antibiotic prescriptions prescribed with penicillin, 23% with macrolides, 20% with cephalosporin, 9% with quinolones, 4% with nitroimidazoles, and 3% with tetracycline. Clavamox, clarithromycin, and cefuroxime were the most prescribed drugs in the penicillin, macrolide, and cephalosporin categories respectively. We further found that the 21-40 age group was the highest receivers of antibiotics (46%). Considering the dosage frequency of penicillin category drug amoxicillin in different brand names including Clavamox, ranoxly, and novaclav was prescribed three times per day. Macrolide category drugs including clarithromycin and cephalosporin category drug including cefuroxime were prescribed two times per day. Results revealed that penicillin category drugs were the most prescribed antibiotics at a young age (21- 40) and brand clavamox (amoxicillin + clavulanic acid) was the highly used antibiotic with a dosage frequency of three times per day.

Keywords*: *Antibiotics, Frequency, Penicillin, Prescription pattern.

Introduction

Antibiotics are one of the most important discoveries in the field of medical science [1]. They are widely used against infectious diseases and essential for treating bacterial Infections, which include bactericidal and bacteriostatic effects [2].

Infectious diseases are common causes of morbidity and mortality in most developing countries of the world. The problem of overuse of antibiotics is a global phenomenon that develops antibiotic resistance worldwide. Antibiotic resistance makes an antibiotic ineffective/less effective against bacterial infections [8]. The antibiotic resistance crisis has been attributed to the overuse and misuse of these medications. In addition, the lack of new drug development, reduced economic incentives, and challenging regulatory requirements have increased the usage of antibiotics [11]. The causes of antibiotic resistance are identified as overuse of antibiotics, inappropriate prescription, extensive use on livestock, etc. [11]. In India, the prevalence of antibiotic usage ranges from, 24% - 67% [2]. According to a recent study, 75% of antibiotic prescriptions were found each year in Sri lanka and it is the most frequent reason for seeking medical attention due to the development of antibiotic-resistant strains [3].

Various antibiotics containing prescription problems have been identified in the health sector, especially in developing countries. These problems include polypharmacy and high usage of drugs with unproven efficacy [2]. Further, irrational antibiotic usage can lead to increased healthcare utilization, morbidity, adverse drug

events, and drug resistance [4]. Therefore, a serious reduction in the use of antibiotics could help to decrease the spread of antibiotic resistance [5].

The prescription patterns of antibiotics will reflect the physician's understanding of the disease, and the health history [3]. In developing countries, antibiotics are the highly consumed medicines, and irrational use of antibiotics has become a common practice [1]. Therefore, it is an essential component in pharmacy services to study and analyze the frequency of prescribing antibiotics, usage, and age-based prescription pattern in a selected population. The present study was focused on, evaluating the prescription patterns of antibiotics in pharmacies in Kottawa, Kalubowila, and Mawanella areas.

Methodology

A Series of observational studies were conducted by obtaining ethical approval from the Ethics Review Committee, Faculty of Health Sciences, CINEC Campus, Malabe. The research was carried out in pharmacies in Kottawa, Kalubowila, and Mawanella areas by analyzing each prescription. A total of 100 prescriptions were analyzed that contained antibiotics. Antibiotics were then categorized according to their name and type. Then the usage of antibiotics was analyzed by considering four different age categories. All data were statistically analyzed by using SPSS software.

Results & discussion

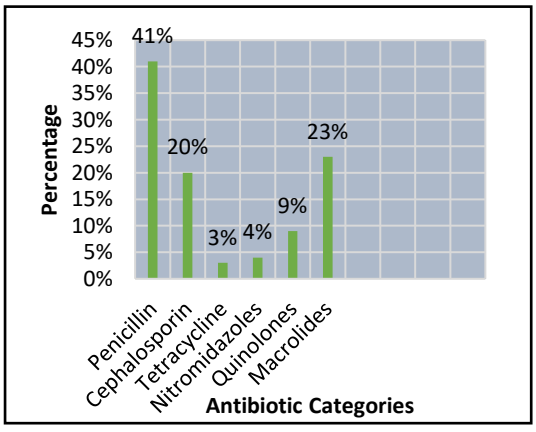

Fig. 1: percentage of prescribed antibiotic categories.

Fig. 1 This graph shows the percentage of prescribed antibiotic categories. The highest prescribed antibiotics category was penicillins (41%), whereas the least prescribed antibiotics category was tetracycline (3%).

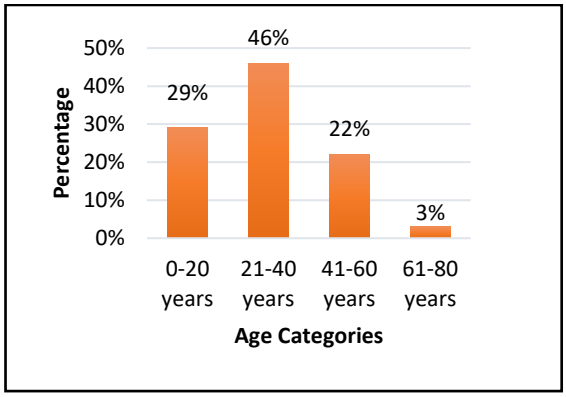

Fig. 2 percentage of dispensed antibiotics according to four age categories.

Fig. 2 This graph shows the percentage of dispensed antibiotics according to four age categories. The age category ranging from 21-40 years shows the highest consumption of antibiotics, whereas the age category ranging from 61-80 years shows the least consumption of antibiotics.

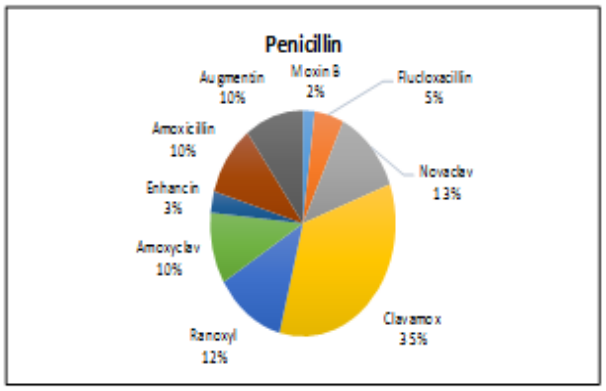

Fig. 3: percentage of prescribed penicillin category antibiotics.

Fig. 3 This graph shows the percentage of prescribed penicillin category antibiotics. The highest prescribed penicillin category antibiotic was clavamox (amoxicillin + clavulanic acid) (35%), whereas the least prescribed drug was moxin (moxifloxacin) (2%).

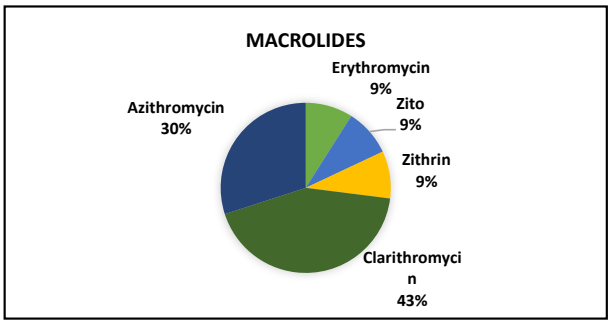

Fig. 4: percentage of prescribed macrolide category antibiotics.

Fig. 4 this graph shows the percentage of prescribed macrolide category antibiotics. The highest prescribed macrolide antibiotics category was clarithromycin (43%), whereas the least prescribed drugs were erythromycin (9%), Zithrin, and Zito (azithromycin) (9%).

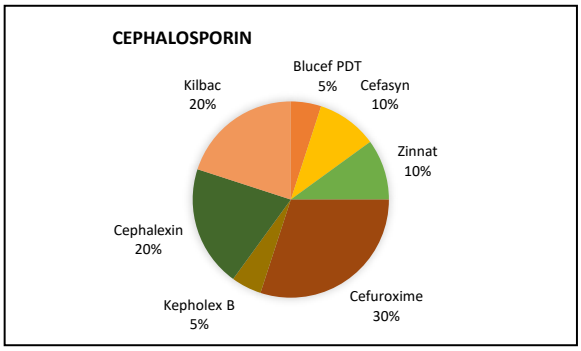

Fig. 5:percentage of prescribed cephalosporin category antibiotics.

Fig. 5 this graph shows the percentage of prescribed cephalosporin category antibiotics. The highest prescribed cephalosporin antibiotics category was cefuroxime (30%), whereas the least prescribed drugs were kepholex B and blucef PDT (cephalexin) (5%).

The usage of antibiotics by a selected population was examined according to the type of antibiotics prescribed among four different age categories. In addition, the frequency of antibiotic usage was observed.

A total of 100 prescriptions were screened. Among them, 100 antibiotics were observed. As a percentage, it was 24.15%. Since the sample size taken for the study was very small, it may affect the validity of the conclusions drawn about antibiotic resistance. According to the obtained results, the majority of antibiotics were prescribed for patients in the age category of 21-40 (46%). The age category belonging to 61-80 years showed the least consumption of antibiotics (3%).

Considering the percentages of most prescribed antibiotics, penicillins appeared to be prescribed in 41% followed by macrolides in 23%, and cephalosporins in 20%. The least prescribed antibiotic category was identified as tetracyclines (3%). Other categories including quinolones (9%) and nitroimidazoles (4%) showed an intermediate prescription pattern.

Considering the dosage frequency of each antibiotic category, which was highly prescribed, the penicillin category drug amoxicillin in different brand names including Clavamox, ranoxly, and novaclav was prescribed three times per day. Macrolide category drugs including clarithromycin and cephalosporin category drug including cefuroxime were prescribed two times a day.

Further, the present study emphasizes that nearly half of the participants (41%) was prescribed antibiotic penicillin from 100 antibiotics observed from 100 prescriptions in the study population. It is mainly amoxicillin in different brand names. Thus, penicillin antibiotics can be predicted to use with high frequency than other antibiotic categories, where developing resistance against penicillin category antibiotics will be more pronounced. In addition, the present study results revealed that most of the early adults (21-40 years age category) are using antibiotics whereby the chance of occurring antibiotic resistance is high in this population which can be a serious threat to Sri Lankan economy.

In a recent study, it was concluded that a vast majority of physicians (97%) believed that widespread and inappropriate use of antimicrobials is an important cause of antibiotic resistance [9]. However, only 60% favored restricting the use of broad-spectrum antibiotics [9]. The dispensing of antibiotics without any prescription has been announced cautious by the World Health Organization as a measure to control the arising of antibiotic-resistant strains

[6]. Considering these facts, it is essential to further develop this study, to find out the dose and the common conditions for prescribing these antibiotics to prevent antibiotic misuse in Sri Lanka.

Since antibiotics are the most prescribed drugs at hospitals in developing countries like Sri Lanka, understanding of drug utilization process is very important [10]. Therefore, necessary steps should be taken to minimize the usage of antibiotics to prevent future complications of antibiotic-resistant strains.

Conclusion

Penicillin category antibiotics following the brand Clavamox, 35% (amoxicillin + clavulanic acid) was the most prescribed antibiotic with a dosing frequency of three times per day. Further, the 21-40 age group was the highest receivers of antibiotics (46%). It is recommended to develop this study further to provide new facts considering the dose and the common conditions of antibiotics use in the Sri Lankan population to develop new policies by relevant government authorities and thereby ensure the safe use of antibiotics at the correct dose with correct dosing frequencies for correct disease for an adequate period.

Acknowledgment

Our sincere gratitude to the dean, Snr.Prof. Menik Hettihewa, supervisors, Mrs. Vishwa De Silva, Ms. Himali Priyadharshani, and the staff of the Faculty of Health Sciences, CINEC Campus, Malabe for giving us this opportunity to conduct this research and providing valuable guidance throughout this research.

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Original Article

Analysis of dispensing pattern of OTC drugs in community pharmacy outlets, Sri Lankan perspectives; a pilot study

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Abstract

The usage of over-the-counter (OTC) drugs all over the world is high, despite many regulatory guidelines. Therefore, this study was conducted to quantitative and qualitative analysis of the dispensing pattern of OTC drugs. A cross-sectional study was carried out for seven days at selected pharmacies and data was recorded using data sheets available at outlets. During the study period, 75 registered medicines were dispensed as OTC drugs. Of them, 40% were dispensed in age below 25, 35% in age category 25-45, 16% in the age category 45-65, and 9% over 65 years. Analgesics (15%), and multivitamins (15%), and others such as dental care products (15%) were dispensed in equal percentages. Only 1% of non-steroidal anti-inflammatory drugs were dispensed as OTC drugs. The highest OTC drugs dispensed in age over 65 years were analgesics and antitussives (29% each) following antipyretics (25%) between 65-45 years age category and analgesics (15%) and antacids (15%) between 45-25 years age category. The most prescribed OTC analgesic was Paracetamol. This study recommended further qualitative analysis of patients' decisions in the usage of OTC drugs related to symptoms.

Keywords: **Over-the-counter drugs, analgesics, antitussives, antipyretics**

Introduction

Over-the-counter (OTC) drugs are medicines that can be sold directly to a consumer without a prescription from a healthcare professional. The individuals who take OTC drugs act as active participants in their health and the treatment of illness. The sale of OTC drugs from pharmacies can help individuals self-manage symptoms as well as time and money. The range of OTC drugs available is often more restrictive compared to prescribed medications and there are often limitations for indications and doses as well [1]. Analysis of OTC drug usage can be beneficial for many parties including medical practitioners, patients as well as drug manufacturing companies. Furthermore, analysis of OTC drugs has an impact both socially and economically. OTC medicines yield significant savings to both consumers and the health care system by reducing the number of physician visits for self-treatable conditions [2]. Literature shows that 81% of adults use OTC drugs as a first response to minor ailments because of their convenience and immediate response. [3]. Elderly people can be identified as the usual OTC drug takers according to related research [4]. Although it is easily accessible for patients, safe use of these drugs requires knowledge, common sense, and responsibility. Inappropriate self-medication with OTC drugs can have serious implications including deaths, especially in extremes of ages (pediatrics and geriatrics), pregnant and lactating mothers [5]. These kinds of effects and OTC drug addiction can be reduced by monitoring the usage of OTC drugs [6]. Both prescriptions only drugs and OTC drugs should need the attention of the consumer's knowledge.

Medication knowledge assessment is used to assess a person's knowledge and ability to read and understand information necessary for appropriate medication use [7]. It will help to ensure the safe and appropriate usage of OTC drugs and early intervention to minimize the risks. This research was carried out to determine the most dispensed OTC drug categories and to analyze the percentage usage of OTC drugs among different age groups. The general objective was to qualitative and

quantitative analysis of the dispensing pattern of OTC drugs.

Research Methodology

This research was conducted as a cross-sectional study. Data were collected from four community pharmacies located in the areas of Aguruwella, Balangoda, Alawwa, and Warakapola. Patients' entries with OTC drugs were recorded for a period of seven days. A data entry sheet was maintained which included the name of the drug, quantity/volume of the specific drug, disease condition, and the age of the patient. Record books of pharmacists and pharmacy databases were also used to record the data. After the data collection, OTC drugs were categorized into 12 categories, and each was divided according to four age categories. Percentages of each dispensed OTC drug were calculated to determine the most frequently dispensed OTC drugs among four age categories. All data obtained were analyzed using the SPSS statistical package.

Result and Discussion

A total of 75 patients' entries were recorded with OTC drugs dispensed at above mentioned community pharmacies.

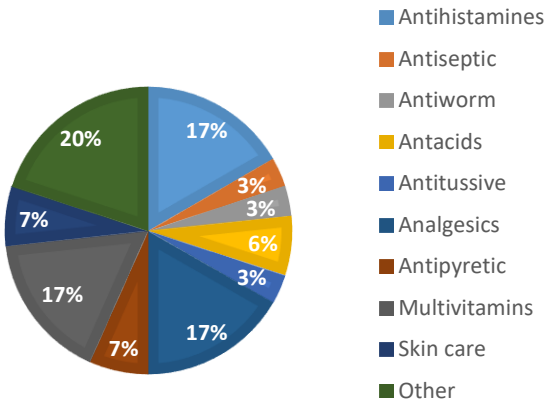

Fig. 1 Percentages of dispensed OTC drugs among individuals below 25 years

The drugs categorized as other (20%) were the most dispensed OTC drug category among this age group. This category includes Samahan, gripe water, and mouthwash. Antihistamines, multivitaines and analgesics were dispensed 17% each. Antiseptic, antiworm, and antitussive were the least dispensed drug categories among this age group (3% each) (Figure 1).

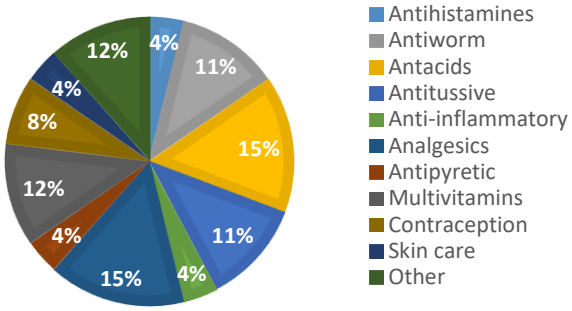

Fig. 2 Percentages of dispensed OTC drugs among those aged between 25- 45 years

Antacids and analgesics were the most dispensed drugs in this age group (15%) following antiworm and antitussives in similar percentages (11%). Other category drugs and multivitamins were dispensed 12% each. The skin care, antihistamines, antipyretic and anti-inflammatory medicines were the least dispensed among this age group (4% each) (Figure 2).

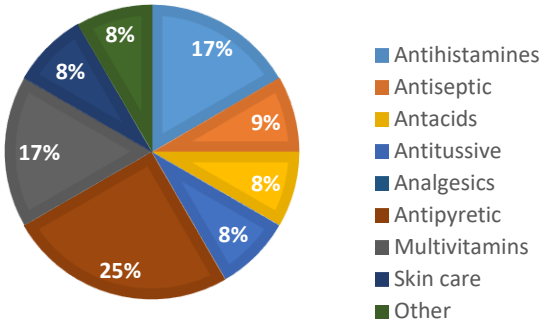

Fig. 3 Percentages of dispensed OTC drugs among those aged between 45-65 years

Antipyretics were the mostly dispensed drugs (25%) among this age group. Multivitamins and antihistamines were dispensed in similar percentages (17%). Skincare, antitussives, antacids, and other category were the least dispensed (8% each) (Figure 3).

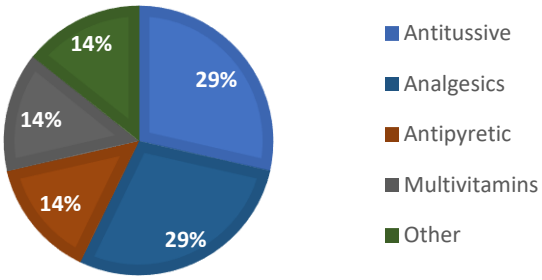

Fig. 4 Percentages of dispensed OTC drugs among age over 65 years

Antitussives and analgesics were the most dispensed drugs in age over 65 years (29%). In other categories, multivitamins and antipyretics were the least dispensed (14% each) (Figure 4).

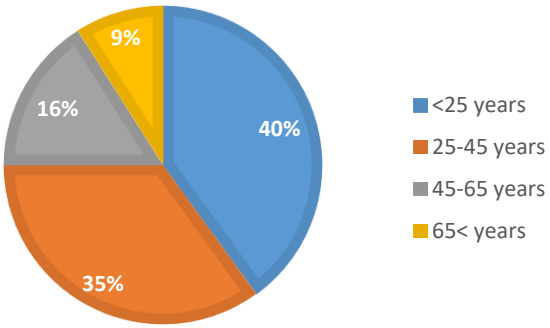

Fig. 5 OTC drugs usage by different age categories

The highest percentage of (40%) OTC drug consumption was within the age group below 25 years, followed by 25-45 years (35%), 45-65 years (16%), and above 65 years (9%) (Figure 5).

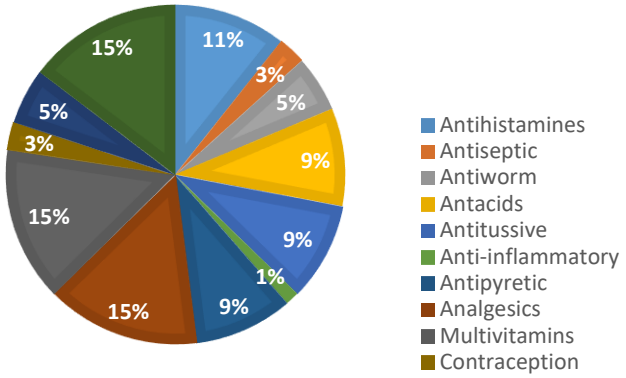

Fig. 6 totally dispensed OTC drugs comparison

This indicates analgesics, multivitamins & other category were the mostly dispensed and obtained with the same percentage (15%). Anti-inflammatory was the least dispensed OTC drug (1%). Antitussives, antipyretics, and antacids were dispensed in equal amount (9%) (Figure 6).

Patients who bought OTC drugs were divided into four age groups to analyse the OTC drugs dispensing pattern. Most OTC drugs were directly purchased by patients mentioning the brand name. Besides, some OTC drugs were listed in the prescriptions as well. The drugs which categorized as other category were the mostly dispensed OTC drug category (20%) among the age below 25 years. This category includes children and infants, and they were used these drugs to prevent minor symptoms like stomach-ache, runny nose etc. This may be probably because of their playful activities. Heartburn, headache, and gastritis were the main symptoms reported by the patients between 25 – 45 years age category, who bought mostly the antacids and analgesics. Skin care, antihistamines, antipyretics, and anti-inflammatory drugs were not much used among the age group between 25 -45 years (4%).

Among the 45 – 65 years age category, antipyretic medicines were the mostly dispensed. Unlike the age below 45 years, the usage of antiworm drugs was not seen among the age category between 45-65 years. When looking at the dispensing pattern of OTC drugs among age over 65 years, most of them

were reported by suffering from a sore throat, joint pain, and headache. Therefore, antitussives and analgesics were the most dispensed drugs within this age group. According to the previous studies similar OTC drug categories were dispensed for similar symptoms in elderly patients [3] [4]. When considering the overall dispensing pattern of OTC drugs among all age groups, it can be predicted that young age people are more likely to consume OTC drugs and it may be due to the occurrence of minor ailments more frequently. Analgesics, multivitamins & other category OTC drugs were the most dispensed drug categories among all the age groups, and as a percentage, those were equally 15%. Paracetamol which belongs to analgesics is more likely to dispense at community pharmacies mainly for the reasons of minor ailments like fever & pain among each age group. Similar results were indicated in the previous study done by A. Mourya *et al* [7]. In addition, Samahan and gripe water were highly used by patients among each age group, and thereby it may account for gaining a high percentage as compared with the other OTC drug categories. Anti-inflammatory was the least dispensed OTC drug category among each age group. As a percentage, it was 1%. The reason for obtaining this much of low percentage may be due to the availability of most anti-inflammatory medicines as prescription-only medicines.

Doctors and pharmacists play a very important role in creating awareness about self-medication by educating the patients. Before suggesting any OTC drug, pharmacists should thoroughly assess the nature and extent of the patient's condition and recommend that they seek expert care when needed. Hence it is suggested that public education is mandatory on the type of illnesses for self-diagnosis and its medication, along with the implementation of stringent rules and regulations on their use. It is also essential to highlight the dangers of OTC drugs on their misuse. [8].

Recommendation

Since the sample size taken for this study was too small, it is a limitation of this study. Therefore, it is recommended to further develop this study for qualitative analysis of usage of OTC drugs by patients relate to their symptoms in all age categories.

Conclusion

According to the results we have obtained, the most dispensed OTC drug categories were analgesics and multivitamins. The most dispensed OTC drug was paracetamol which belongs to the category of analgesics. The age category below 25 years was identified with high consumption of OTC drugs.

Declarations

We would like to forward our sincere gratitude to our faculty dean Snr. Prof. Menik Hettihewa, Snr. lecturer Dr. Rashini Baragamaarachchi, Mrs. Vishwa De Silva, and Mr. Weranga Rajapaksha the lecturers in the Faculty of Health Sciences, CINEC Campus for their valuable support and comments on the manuscript. We express our thanks to the pharmacists of the selected pharmacy outlets for allowing us to use their space for conducting this research study and for being cooperative in the process to become its success.

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Original Article

Analysis of Knowledge, Usage and the Practice of Total Body Care Cosmetic Products in Western Province; Sri Lanka

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Abstract

Cosmetic care product are used for skin, hair and nail caring practices. The cosmetic product regulations in Sri Lankan regulatory authorities is not properly implemented for importing and marketing thus it is needed to prevent the misuse and related adverse events. As an initiative, our team investigated data on knowledge of cosmetic care, and the practicing methods of the participants in western province in Sri Lanka as a phase 1 study. It was a descriptive cross-sectional survey and participants aged from 18 to 70+ years were openly invited. Informed consent was included in the self-administered questionnaire, validated before proper research. It includes questions on knowledge, attitudes, and practice of cosmetic usage. Our data showed that majority were female (71%), age group of 18-39 yrs (93%). 92% of them are Sinhalese, and 17% of Musilms. 93% of participants were aware reasons for using cosmetic product and 68% of them were aware composition of and adverse effects. 93% of them were aware about risk of allergy and 89% of them uses skin and body products. Average using time was more than 5 years by 39% and 31% used it for 1-5 years, rest of them less than one year respectively. Use of cosmetic is mainly for minor skin abnormalities (24%) and to enhance the appearance (16%) others included both reasons (60%). Majority had used both herbal and cosmetic products (63%). 61% of them preferred both local and international products. Most of them had referred social media for the selection of the product. We concluded that participants from western province showing expected personal knowledge on composition, indications, and potential adverse effects. This data is important to consider for preparing cosmetic rules and regulations and also recommend proper scientific based audio and visual educational program in selection process.

Keywords: cosmetic care product, Knowledge and practice, Sri Lanka.

Introduction

The advancement in the cosmetic industry and the production of large number of products all over the world has resulted in an increase of personal care product consumption. Variety of inclusions in all cosmetic products had led to excessive exposure of the world population different types of chemicals which can induce adverse health effects (1, 2). Out of some chemical, parabens and phthalates are the most concerned harmful chemicals found in personal care products (3). Various analytical methods have been developed to evaluate the content of these chemicals in different sample. For an example, parabens is used commonly in cosmetic products and it is a endocrine disruptors in some in vitro screening tests (4) The negative impact of harmful chemicals in cosmetics can affect the environment and animals (5). In our literature survey, few studies were found out in different countries. They have evaluated the consumption pattern of cosmetic products s in different populations. Biesterbos *et al*. had evaluated the use frequency of thirty-two cosmetics including general hygiene, skin care, hair care, and makeup products in the Netherlands (6). Furthermore, another study displayed in France by Ficheux *et al* on consumption pattern of products among French consumers (7, 8).

Sri Lankan cosmetic industry emerged within last 8 years and changing from primary functional product to more advanced products now. Therefore, our team hypothesized to conduct a survey-based research to find out the usage of cosmetic products in our country to evaluate the health risks for consumers. Finding of this data would be helpful to determine the exposure risk of consumers, potential adverse events, usage prevalence, and usage frequency.
According to the report of Mushtaq *et al* to the International News Services.com, in 2014 Sri Lankan Local Market had a collection of 4000 cosmetic and beauty care products as per a report of Cosmetic, Devices and Drugs Authority. Furthermore raising of the purchasing power of

consumers and raised awareness and concern in beauty and hygiene has positively impacted the growth of beauty care industry (9-11). According to a study conducted in the Galle district of Sri Lanka in 2019 on popularity and usage of Skin care products, 53% used skincare agents, rest of them do not use any such products (12)

According to a study conducted among female population in Saudi Arabia it was revealed that majority used cosmetic products on a daily basis. >50% had reported the use of deodorant, sunscreen, and night cream once a day, and 40% indicated lipstick/balm, shower gel, body lotion, makeup remover, and eyebrow pencils one time per day (14). As scientists, we reiterate the fact that simultaneous use of cosmetic products with same ingredients without insight would lead to aggregate body system exposure and (15). Therefore, data on co-use of different products containing same chemicals are also important for health risk assessment in our country (14).
Parabens are used as preservatives and phthalates are used in nail polishers and hair sprays (16). But most of these chemicals are toxic and adversely affect different body systems (17). Other chemicals can also be found in cosmetic products such as triclosan, heavy metals, hydroquinone, and nitrosamines can cause negative health impacts including allergy, endocrine disruption, birth defects, neurotoxicity, or cancers (18). According to a study conducted among female population in Saudi Arabia it was revealed 16% of the participants had experienced adverse effects from the use of cosmetic products. The most complained cosmetic products were lotions (51%), face creams (27%), and deodorants (10%). Most reported adverse events were redness, itching, skin soreness, breakage of hair, eye inflammation, darkening of armpits, and discoloration of face (9).

Although it is clear that Sri Lankan population is using different types of cosmetic products, research on the prevalence and usage of cosmetic products with a focus on health risks are scarce. In order to assess health risks for consumers and to determine the bad effects on the body systems, use prevalence, frequency, and co-use pattern of these products should be done in our country. Little is known about the cosmetic product usage and practice in Sri Lankan population and this study was conducted to fulfill the gap. Findings from this study will provide baseline information on important predictors such as percentage of users, frequency of use, co-use pattern of cosmetics, and their adverse events among Sri Lankan Population. Findings from this study could be used by all the health care policy makers and regulatory authorities to take measures on the health risks caused by cosmetics and to educate not only the general public but also relevant production companies on them.
The provided information can be useful in developing consumer exposure model and we have to do the aggregate exposure assessment in phase 2 of this study.

Research Methodology

Study was done as descriptive cross-sectional survey in population in the Western Province of Sri Lanka and online survey was the tool for data collection. Based on the statistical data and official figures released by the Department of Statistics and Information, estimated population of the Western Province of the country for the year 2020 is 6 million. Non probability convenient sampling type is used and based on the western province population, 385 participants were included within 95% confidence interval with a 5% margin of error. All inclusion criteria were outlined in the participant information sheet attached to the survey. This study considered both male and female population. The study included participants aged from 18 to 70+ years and members who cannot grant consent were excluded. Informed consent was obtained through the first part of the Google Form and self-administered questionnaire comprising of 17 questions was validated properly before conducting the proper research. A total of 11 questions were done to assess the knowledge, attitudes, and practice of the participants regarding cosmetic usage. All the compulsory details on the aims, methods and contact information of the researches were mentioned in the information sheet where the participant can direct their problems related to the study through a call. Participant's informed consent was taken through the consent form via google link. Ethical clearance was obtained from the Ethics Review Committee, CINEC Campus Sri Lanka.

Statistical Analysis

The descriptive data in terms of percentage and frequency were used to demonstrate the findings. The chi-square test was used to assess possible relationships between different variables. For all statistical tests, a value < 0.05 was considered significant. Spearman correlation coefficient (R) was used to measure the strength of correlations between the uses of different products.

Results

Majority of responders were found to be undergraduate, female (71%). 93% of them are aware about the cosmetic products, 68% of them are aware about the composition of the cosmetic product and 69% of them were convinced about the potential adverse effects. 25% of the participants had experienced with side effects related to the cosmetic product usage. 39% of the participants had withdrawn the use of the product and rest had continued the product they selected. 93% of participants are aware about potential allergies,

Figure 1A shows that percentages of using skin/body care products, Hair/ nail products and Facecare, lip and eye care products by the western population. .

Figure 1

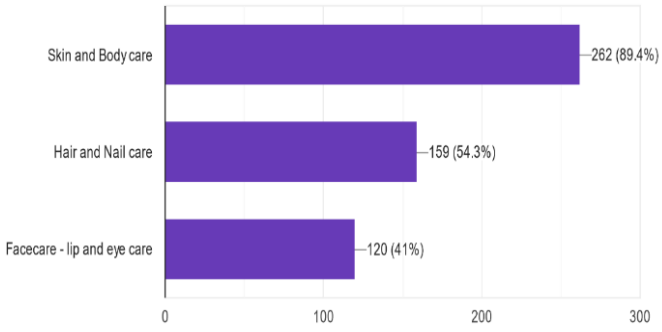
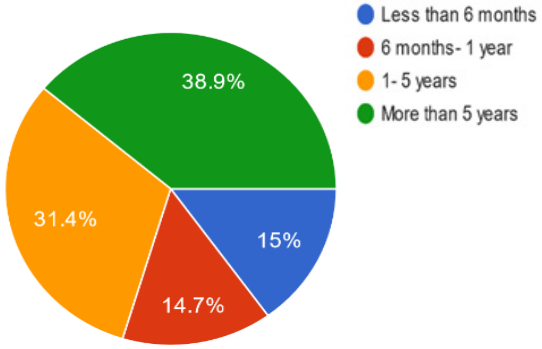


Fig 1A: percentages of usage pattern of skin/body care products

Figure 1 A shows the percentages of usage pattern of skin/body care products, Hair/ nail products and Facecare, lip and eye care products by the western population.

Changes of the duration of the use of cosmetic product is given in figure 1B and three reasons for selecting cosmetic products were analyzed and data were illustrated in figure 1C

Figure 1B and 1C



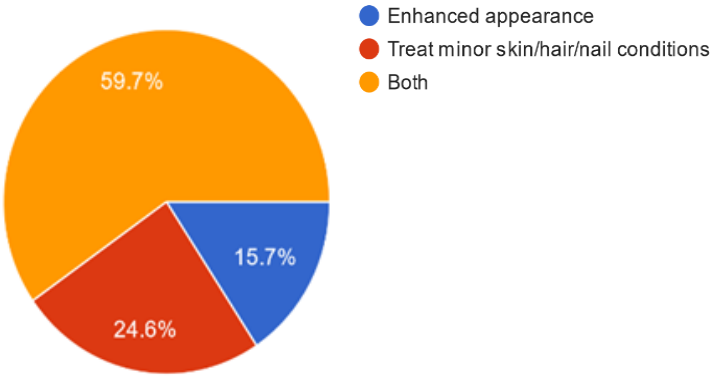


Fig 1B: The time duration of the use of cosmetic product by participants

Fig 1C: The reasons for selecting cosmetic products by participants

Figure 1A and 1B shows the time duration of the use of cosmetic product by participants. The reasons for selecting cosmetic products by participants were given in figure 1C. Data represents percentage analysis by SPSS.

Most of the participants said that they use both herbal and synthetic products and also majority had no choice it as local or international product. We found that 56% of participants, had brand preference and 44% of them are not interested in any brand.

We also analyzed the sources of information which they had referred for the selection of the cosmetic product. Figure 2A showed the results and most common resource is the social media.

Figure 2A

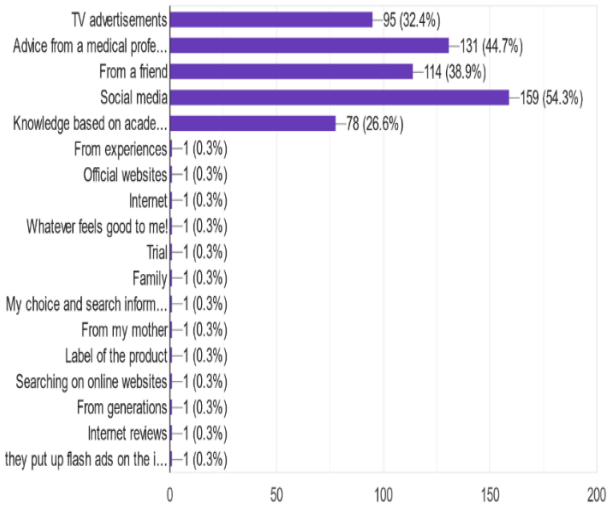


Figure 2A: the data related to reference sources about cosmetic product for selection by the participants from western province in Sri Lanka

We further analyzed the data in relation to the places for the common purchasing sites in western province. Majority of participants had bought products from cosmetic outlets, and others buy from supermarkets and online stores. Figure 2B

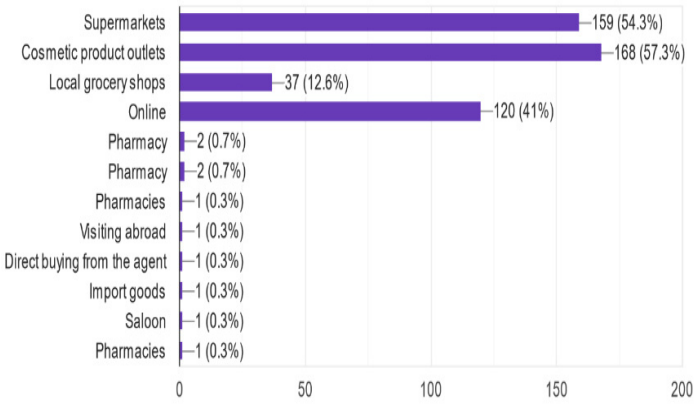
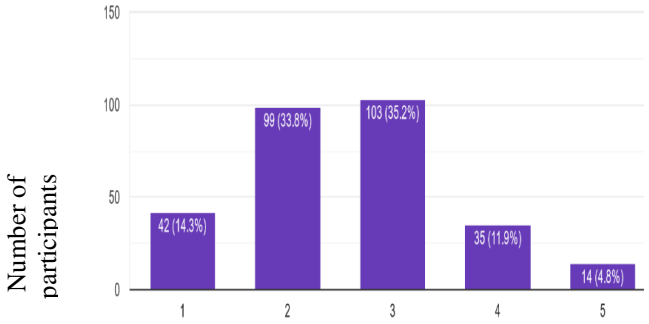


Figure 2B: the data related to common sites of the purchase of the cosmetic products by the participants from western province in Sri Lanka

We also tested the knowledge on the adverse events/ effects of the cosmetic product utilization. Figure 3 shows the results of our study. We used a strongly agree (1) to strongly disagree (5) scale to analyze the following results.

Figure 3



1 strongly agree, 2 agree, 3 neutral , 4 disagree and 5 strongly disagree

Fig 3: knowledge on the adverse events/ effects of the cosmetic product utilization

Further, our team also researched on the monthly expenses by the participants for the cosmetic product procurement. Majority spend less than 1000 rupees per month

Monthly cost for cosmetic products

	Frequency	%	Valid %	cumulative %
Less than LKR 1000	134	45.7	45.7	45.7
LKR 1000-5000	131	44.7	44.7	90.4
LKR 5000-10000	22	7.5	7.5	98.0
More than LKR 10000	6	2.0	2.0	100.0
Total	293	100.0	100.0	

Table 1 : monthly expenses by the participants for the cosmetic product procurement. Majority spend less than 1000 rupees per month.

Our team also investigated on the qualitative analysis of the cosmetic products usage of our participants. (Figure 4)

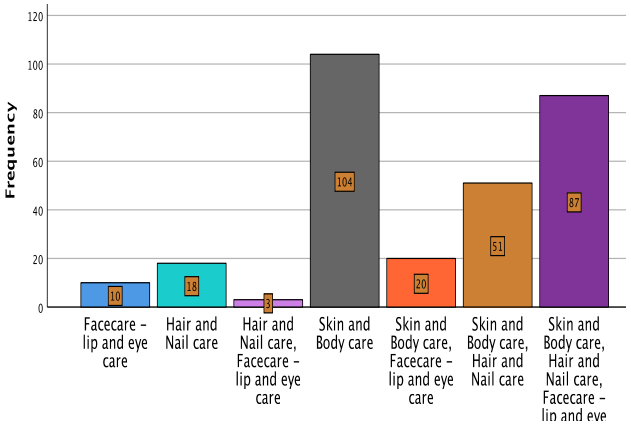


Figure 4: qualitative analysis of the cosmetic product usage among our participants.

Figure 4 shows the qualitative analysis of the cosmetic product usage among our participants. Majority use for skin and body care products while least expense were done for hair, nail lip and eye care. Analysis by SPSS.

We also analyzed the participant's knowledge of long term usage effects of cosmetic product. Figure 5A shows that majority are not aware any risk of malignancy with cosmetic product usage. Figure 5B shows the knowledge about importance of using cosmetic supportive products in elderly.

Figure 5A

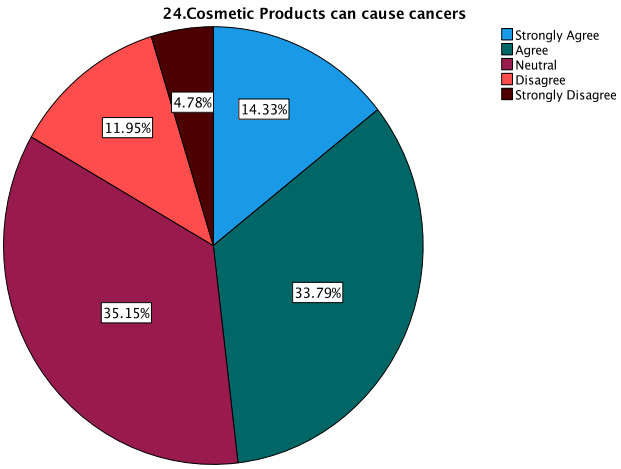


Figure 5A : participants knowledge analysis on long term risk of malignancy with cosmetic products.

Figure 5B

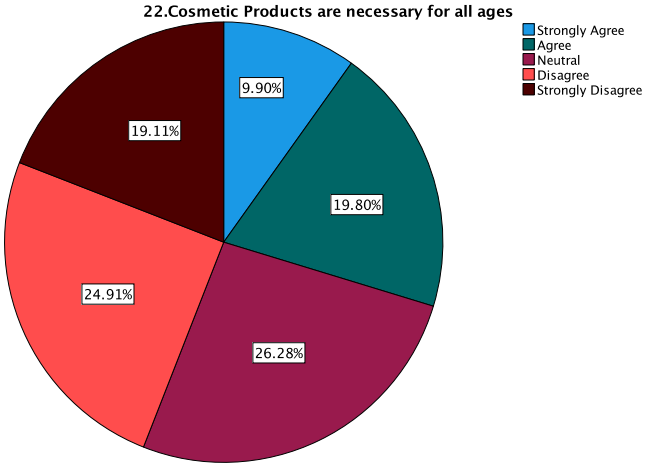


Figure 5A : participants knowledge of using cosmetic product in different age.

Discussion

We conducted this research to facilitate the availability of the date in relation to cosmetic care products in Sri Lanka. We could not find any research or date in relation to this spatiality despite competitive tailor made shops /market and social media marketing. Therefore as a national requirement, we are happy to submit the data of cosmetic product usage and practices which may be useful to the government for formulating the regulations in importing, marketing and usage. We found that Sri Lankan adolescence use the local and international products more or less equally despite their low cosmetic budget. As we highlighted in our research paper, most of the chemicals which are included in many cosmetic applications available here are harmful to different systems of the body in acute and chronic manner. Cosmetic product registration after ingredient analysis is not practiced in Sri Lanka before marketing. Our research indicates the high usage of these products and it will have a serious after effects in near future.

Most interestingly clients take the social media as the best reference learning center. This is very important finding to be considered seriously because social media is one of the place with unregistered local and international cosmetic products. High reference rate of this site can be associated with predictable high risk to the society. Sri Lankan

regulatory is not involved in social media marketing regulation and it is more dangerous due to the absence of marketing surveillance program for these unregistered products in our country. Our study showed society spent considerable amount of money for cosmetic products and it is a responsibility of the government regulatory authorities to address this issue and minimize the cosmetic product based adverse events. Considering the total results of this study, we recommend for more standard wellness education program about cosmetic usage and cosmetic product selection, criteria and activities.

Our next plan to continue with the product based cost effective analysis after understanding the common practices used by Sri Lankan society. Our team want to this as one of the take home message of this exercise and all relevant stakeholders should consider in educational program on cosmetic product selection, usage, requirements, and common ingredients. We concluded that participants from western province showed significant percentage of knowledge on composition, indications, potential adverse effects of the product but they need proper education on selecting all types of cosmetic products. We recommend audio and visual media to be conducted via cosmetic regulatory authorities.

A. Study Limitations

This study was confined to the western province and it may have limited the extent of the results.

B. Acknowledgements

Authors would like to be thankful to Ms Himali Kumari, former lecturer and Mrs Kanchana Ekanayake lecturer in CINEC Campus for the intellectual contribution given in preparing the research proposal for Ethics committee. We also are grateful to the all participants who had volunteered to the study.

D. Conflict of Interests

No conflict of interest exist in this publication.

E. Human and Animal Related Study

If the work involves the use of human/animal subjects, each manuscript should contain the following subheadings under the declarations section-

F. Ethical Approval

This study was reviewed and approved by the Ethics review committee in CINEC campus.

G. Informed Consent

Informed consent which was approved by the ERC of CINEC campus was shared with the participants before the proper questionnaire. Write a statement of informed consent taken from the participants to publish this research work. The editor may ask to upload scan copy if required.

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Original Article

Assessment of Opinion and Awareness of the Construction Industry on Suitability of M Sand as a Replacement to River Sand

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Abstract

Fine aggregates are an essential raw material required for concrete production. Majority of the fine aggregate demand is supplied through natural river sand. However, river sand mining is not sustainable in the long run and impacts the environment severely. A more sustainable and cost-effective replacement to river sand should be adopted quickly. Manufactured sand or M sand is a promising alternative to river sand. The suitability of M sand as a replacement to river sand and the opinions and perspective of the construction industry were assessed by doing a comprehensive literature review and collecting data from industry professionals through a questionnaire. The questionnaire was assessed under their categories such as performance, economy, environmental and general. Respondents were also asked to grade their presumed knowledge on each category being assessed, in order to evaluate the validity of individual opinions. The results indicated that the opinion of construction industry professional's regarding M sand on economic and environmental aspects are similar to the findings of the literature. However, the professionals opinions regarding performance aspects of M sand was mostly mixed and contradicts with literature findings. Professionals who rated their knowledge highest had different opinions about M sand indicating the presence of severe misconceptions and inadequate knowledge within the industry. To overcome this, industry professional's knowledge on M sand should be raised by providing accurate information about M sand and its benefits. Furthermore, the industry professional's opinions acknowledged that M sand is being currently underused within the industry. They were confident that in future, M sand use would increase drastically.

Keywords: M Sand, River Sand, Fine aggregates, Awareness, Construction industry.

Introduction

The world population grew rapidly over the past few decades and this has resulted in a rapid infrastructure growth across the globe. This rapid growth has created an immense pressure on the construction sector to manufacture massive quantities of concrete worldwide. And the raw materials used for concrete has a large influence in the cost of the infrastructure being developed. In the raw materials used for concrete, natural river sand forms about 35% of the total raw materials the use of sand as a raw material has already surpassed its natural renewal rate [1] .The use of river sand has led to and excessive amount of sand mining. Because of this, the environment has been damaged severely. So it is essential to look for other substitutes for river sand which is more eco-friendly and cost effective [2]. River sand is not available locally which results in it being transported to long distances which is not economical or environmental friendly while M sand is available locally which makes it attractive to customers. When price of M sand and river sand is compared, normally M sand is almost 50% cheaper than river sand [3].

Even when natural sand replaced completely with alternatives such as with M sand and quarry sand, the strength properties deem to be preserved. But total replacement of natural sand with M sand or quarry sand resulted in low workability of the concrete. Therefore it is only recommended for low workability purposes [4]. It has also been studied that replacing 50% of river sand with M sand in concrete production generated superior results in strength and durability properties when compared to traditional concrete produced with river sand [5]. Even with the benefits associated with M sand, it is seen that the use of M sand in the construction industry still relatively low compared to river sand even as a partial replacement. It is fair to assume that

the knowledge regarding M sand the construction industry plays a vital role in promoting or eliminating its use in construction applications. Therefore this study aims to assess the degree of awareness and opinions of the construction industry with regard to the suitability of M sand as a replacement to river sand in construction applications.

Research Methodology

A comprehensive literature review was carried out on M sand and natural river sand mainly focusing on their performance, economic and environmental aspects. Using the information collected through the literature review, a questionnaire was compiled. Important data which is essential for this research was collected through the questionnaire given to industry professionals such as Civil engineers, Quantity surveyors, academics in Civil engineering field and contractors. With careful consideration, eight questions were compiled in following contexts.

1. Workability of concrete made with M sand compared to river sand.
2. Strength of concrete made using M sand compared to river sand.
3. Durability of concrete made using M sand compared to river sand.
4. Overall cost of production of M sand compared to river sand.
5. Environmental impact caused by production of M sand compared to river sand.
6. Availability M sand compared to river sand.
7. Current use of M sand in construction industry in comparison to river sand.
8. Use of M sand in future construction industry in comparison to river sand.

The respondents were asked to give their opinion out of the 5 responses shown in Table I, based on how they view the attributes of M sand compared to river sand.

Choice No	Response
1	Significantly low
2	Relatively low
3	Approximately the same
4	Relatively high
5	Very high

Table I Type of responses presented in the questionnaire

The presumed knowledge level was measured by including a question where the respondents are required to rate their presumed knowledge level for the relevant category on the scale of 1 to 10 (1 - very low, 10 - very high).the questions were categorized as shown in Table II.

Question No	Category
1,2,3	Performance
4	Economic
5	Environmental
6,7,8	Use and availability

Table II Categorization of questions

This knowledge level data is critical to analyze the responses in more practical manner as it allows to check the validity of the responses against the presumed knowledge of the respondent.

Results and discussion

As shown in Fig. 1 & Fig. 2, the majority of respondents deem to think that strength and durability of concrete made of M sand is not different from the concrete made of river sand. Some studies conducted on the strength aspect of concrete made of M sand suggest that compressive and flexural strength can be increased with partial replacement of M sand up to a certain extent [6][7].

When it comes to workability, many studies support to establish the fact that use of M sand results in low workability of the concrete [4] due to the angular form and relatively rough surface of sand particles [7]. The results shown in Fig. 3 indicates that most would agree to this or stay neutral to this phenomenon. The respondents who agrees with

literature also rated their knowledge to a relatively high level. This indicates that this fraction of respondents are somewhat knowledgeable in this regard.

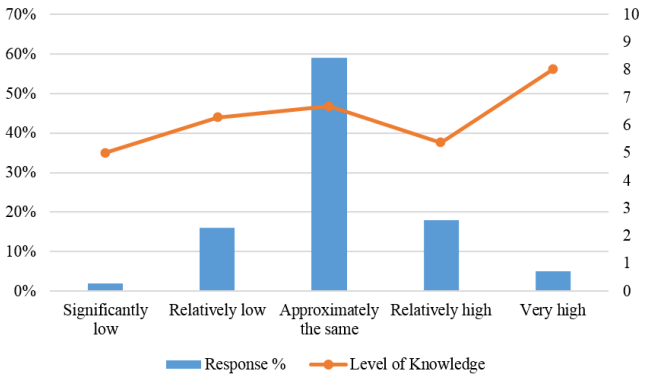

Fig. 1 Strength of concrete made with M Sand compared to river sand

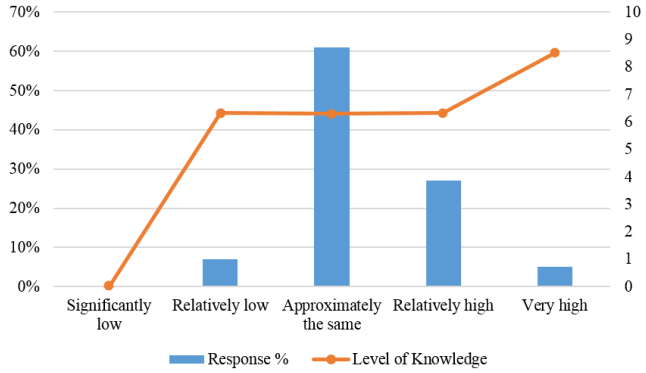

Fig. 2 Durability of concrete made using M Sand compared to river sand

It can be seen that the respondents who provided their opinion as approximately the same which agrees with literature, tend to rate their knowledge at moderate levels. It also can be observed that industry professionals who rated their knowledge the highest has made quite extreme opinions which deviates from the existing knowledge. However this portion is relatively low compared to the majority.

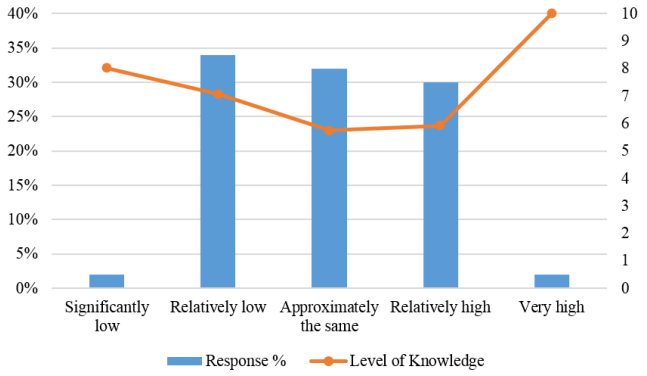

Fig. 3 Workability of concrete made with M Sand compared to river sand

It has been established that the M sand is a cost effective replacement for river sand when it comes to economical production of concrete [4] [5]. Around 60% the industry professionals also tend to think that the overall cost can be reduced as shown in Fig. 4.

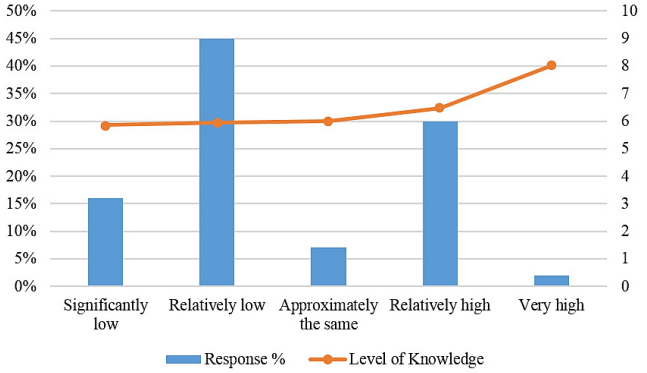

Fig. 4 Overall cost of production of M Sand compared to river sand

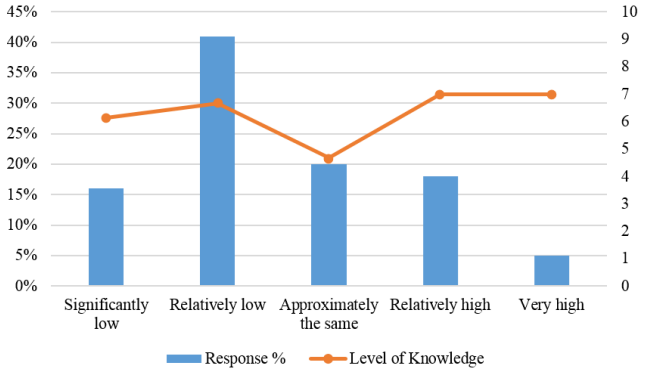

Fig. 5 Environmental impact of M Sand production compared to river sand

When the industrial professionals were asked to give their opinion on the impact of M sand production on the environment, majority of them (55%) believes

that the impact is less than that of river sand as exhibited in Fig. 5.

When it comes to the current availability of M sand, the results indicates that the overall opinion is somewhat divided among the high and low availability. However the level of knowledge the respondents assigned for extreme opinions are relatively low. Also majority of the professionals suggest that the current use of M sand is also relatively low or significantly low compared to river sand. However, people who gave their opinion as "significantly low" also marked their knowledge at low level. In overall it is fair to assume that the awareness with regard to M sand availability and use in the local industry is not at a satisfactory level.

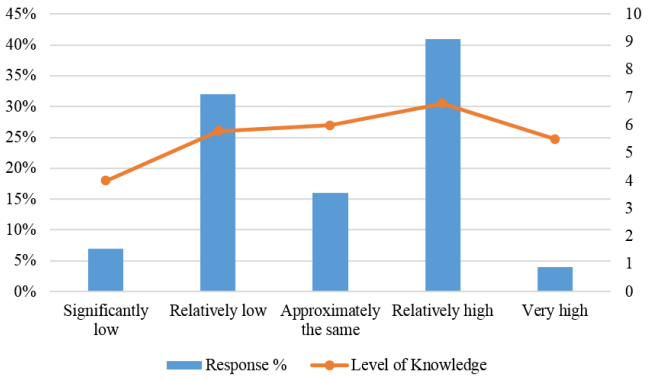

Fig. 6 Availability of M sand compared to river sand

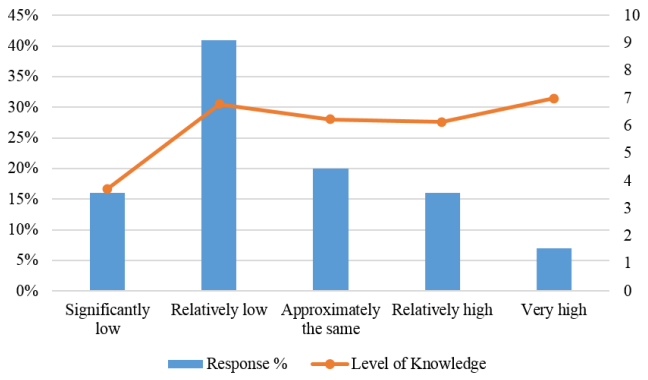

Fig. 7 Current use of M sand in construction industry in comparison to river sand

When it comes to the future use of the m sand, almost 70% of the industry professionals were optimistic and predicted that the future use will be increased. In the other hand respondents who predicted low use also rated their knowledge the least. In overall, it is evident that the opinion of the industry is in favor of increased utilization of M sand as a replacement to river sand.

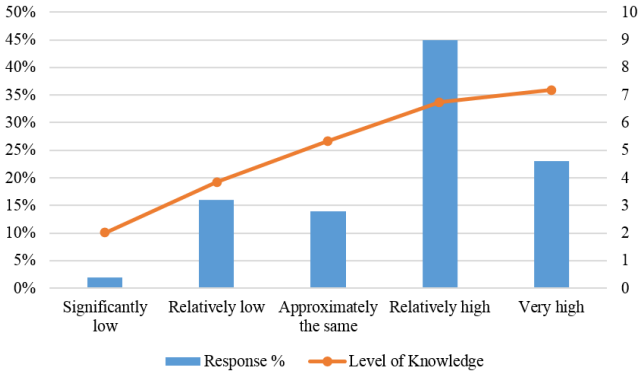

Fig. 8 Future use of M Sand in construction industry compared to river sand

Category	Average level of knowledge	Standard Deviation
Performance	6.40	2.6
Economic	6.13	2.78
Environmental	6.25	2.67
Use and availability	6.09	2.56

Table III Average knowledge level

Table elaborates the self-assigned average level of knowledge for each category investigated in the study. Even though not much deviation can be observed, it is evident that respondent's knowledge on performance aspect shown to be more promising compared to other categories. In the other hand the awareness on use and availability of M sand deem to be scarce. However the high standard deviations of all data indicates that the self-assigned knowledge levels varies in much broader range.

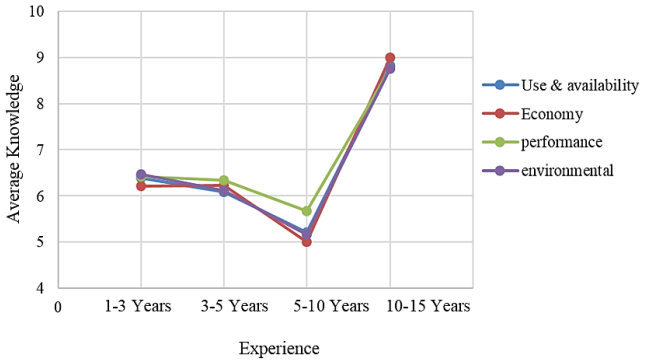

Fig. 9 Association between experience and knowledge level

The association between experience of the participants and the level of knowledge is shown in the Fig. 9. Generally it is expected to increase the knowledge as the experience grows. But still this can be governed by the exposure to the updated knowledge associated with the industry. In overall, mid-career professionals with 5-10 years of experience had the lowest average self-assigned knowledge about M sand. It was also observed that even though professionals who are highly experienced and rated their knowledge the highest, failed to provide opinions which are valid in terms of existing updated knowledge.

Conclusion

In order to promote an alternative to river sand it is important that the construction industry understand the advantages and disadvantaged of such alternatives. Without such awareness among industry professionals, it is difficult to assume that implementation of such alternatives will take place. This study aims to assess the degree of awareness and opinions of the construction industry with regard to the suitability of M sand as a replacement to river sand in construction applications.

Form the study it was determined that majority of the industry professionals tend to agree with the existing scientific knowledge regarding the performance, economic. Environmental and availability aspects regarding the M sand in comparison to river sand. Out of these aspects, opinions regarding performance aspect showed the highest reliability. In the other hand use and availability aspect showed considerable lack of awareness and confidence.

Even though the opinion of the industry is at a satisfactory level. It is also important to notice that significant fraction of the industry professionals show lack of awareness in many aspects. Also both overestimation and underestimation of own knowledge found to be significant as indicated by the outcomes of the study. This could be overcome by providing awareness programs through relevant professional institutions about the use of sustainable and environmentally friendly fine aggregates like M sand.

On the positive side, the industry professionals were optimistic and predicted that the future use will be increased. This sort of confidence is important for the promotion of M sand as a fine aggregate replacement in the construction industry

River sand is most preferred because M sand and river sand do not have a drastic price difference and constant river sand supply through illegal means to the industry.

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Original Article

Evaluation of Practice on Self-Medication among Allied Health Science Undergraduates of Sri Lanka, Therapeutic and Toxicity Implications

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Abstract

The main purpose of the study was to assess the prevalence of self-medication, classes of drugs used as self-medication, identify the patterns of self-medication practices, and examine sociodemographic characteristics, factors that correlate with self-medication and adverse drug reactions caused due to self-medication. A descriptive cross-sectional study was conducted among Allied Health Science undergraduates of Sri Lanka who have practiced self-medication during past 2 months prior to data collection. This study was conducted after obtaining the ethical approval from Ethics Review Committee, CINEC Campus, Malabe. The data were collected as a google form. According to the results, the percentage of the prevalence of self-medication was 59.45%. Commonly used medicines were analgesics, antipyretics (77.82%), expectorants, antitussives (36.95%) and antibiotics (24.34%). Some of the reasons why undergraduates practiced self-medication were influenced from previous experience (62.17%), previous doctor's prescription (34.78%) and because of the convenience (30.87%). Headache (70%), gastritis (35.21%), running nose (27.82%) and fever (27.39%) were the main four conditions for using self-medication. The reported adverse drug reactions were headache (40.00%), vomiting (22.17%), nausea (20.43%) and diarrhea (13.04%). In conclusion, more than half of the respondents (70%) think that self -medication is safe yet, most participants faced with adverse drug reactions (56.72%). Therefore, we suggest educating the people and implement policies regarding selling, advertising, and the safe use of self-medicated drugs, to prevent the adverse drug reactions.

***Keywords**: Self-medication, Undergraduates, and Adverse drug reactions*

Introduction

According to the interpretation of World Health Organization (WHO), Self-Medication (SM) is, consuming a drug to an unknown disease by a person, without consulting a medical practitioner [1]. When SM is practiced under the guidance of a reliable medical information with appropriate knowledge & health frontage, it is defined as 'Responsible Self-Medication (RSM)'. Recently SM has provided positive effects by facilitating the consumers to overcome challenges caused due to minor illnesses. Further, SM helps to minimize the congestions at medical centers, time wastage of consumers having severe disease conditions. However, RSM can also be vulnerable to the consumers, as it can lead to misdiagnosis of diseases and unfavorable health hazards which will often need medical consultations [2]. Therefore, there is a consideration of implementing new policies by relevant authorities to name, safe and effective medicines to ensure safe Self Medication Practices (SMPs) [3],[4]. Moreover, it has been identified that, demographic and socio-economic factors including age, gender, educational level, and various policies followed in different countries have an impact on SMPs. These factors can be considered in understanding the level of knowledge, attitude, behavior, and practice of those who self-medicated to a certain extent. Therefore, it is important to examine these factors and how these factors correlate with self-medication among consumers [5], [6].

The global prevalence of SM is identified with a higher rate (93.7%) [7], while increasing the need to implement more policies and to draw more attention of health authorities towards SMPs. Thus, the sources, common drugs, common conditions, and risk factors of SM should be initially identified

to prevent harmful risks of SM [7],[8]. It has previously been observed that common reasons for practicing SM were minor health problems (32.5%), advice from relatives and friends (26.2%), followed by easy access to internet, drug availability, previous experience, medical cost, time saving and lifestyle [9]. Then, depending on a recent study, the minor health problem that led people to self-medicate were pain, cough, cold, flu followed by fever, dysmenorrhea, and gastrointestinal disorders [10]. According to R.K. Verma *et al*., in 2014, in many countries SM was mainly done using over-the-counter medicines (OTCs) in addition to herbs and traditional medicines [11]. Even the general policies implemented by WHO has shown that the term 'over-the-counter medicines' were widely used to describe self- medicated drugs [12]. However, another study has shown that the OTCs associated with severe adverse effects and even death to consumers due to drug overdose and drug interactions [5]. For example, in 2001 Stevonson. R et.,al, reported that two women were dead during winter flu pandemic by using OTCs; one due to hemorrhagic duodenitis caused by OTC medicine ibuprofen and the other due to overdose and misuse of paracetamol with another drug product [5],[13]. However, based on a recent study conducted by Malak and Abu Kamel in 2019, the most used drug classes for SM were painkillers including paracetamol and anti-inflammatory drugs (56.3%), followed by antibiotics, vitamins, antipyretics, and antihistamines [10]. Furthermore, it has been found that prescription-only-drugs (PODs) also have recently been used for SMPs in many developing countries [3], [4],[14]. Health hazards like antimicrobial resistance (83%), drug abuse (99.4%) and drug dependency (70%) have arisen because of misuse of SMs in many developing and developed countries [3],[4],[14],[15]. It may result in severe drug interactions with body compartments that may leads to increase toxicity risk. For instance, antibiotics have reduced the number of illnesses and deaths due to infectious diseases, but the misuse of antibiotics in the form of SM has led to antibiotic resistance. Further, painkillers including paracetamol has been found to be relatively non-toxic when given in therapeutic doses but may be toxic when taken in overdose [15]. Furthermore, a review article by Ruiz, has shown that, potential risks such as incorrect self-diagnosis, incorrect doses with incorrect dosing frequencies have arisen due to non-responsible self-medication [16].

Therefore, non-responsible SM results in serious health hazards without proper education. As a developing country, Sri-Lanka faces the same situation as there is a less awareness about the adverse drug reactions caused by SMPs. Moreover, In Sri Lanka there is insufficient research on the evaluation and quantification of the SMPs among public community and health science undergraduates who were more dependent on SMPs. The purpose of this study was to provide a better education of SM as well as proper awareness about adverse drug reactions. Further, recent foreign studies have showed that PODs have used for SMPs [3]. They have led to dangerous health hazards and misuse of drugs. In Sri Lanka one research study has been carried out for SMPs among athletes [17]. But there were insufficient research findings among young generation including university students on SMPs. Therefore, there was a consideration to evaluate the SMPs among Allied Health Science undergraduates in Sri Lanka to fill the literature gap, to get an idea about SMPs and to get an idea about adverse drug reactions upon usage of SM. Considering these facts, this study was focused on identifying the practices of SM among Allied Health Science undergraduates in selected universities of Sri Lanka.

Research Methodology

A descriptive cross-sectional study was conducted among Allied Health Science undergraduates in Sri Lanka with the approval of Ethics Review Committee of CINEC Campus, Malabe, Sri Lanka. Respondents were given a pretested questionnaire which consisted of both open ended and close ended questions. It was prepared in all three languages of Sri Lanka; Sinhala, Tamil, and English as a google form. It was consisted with two main parts. The first part (Part A) consisted with sociodemographic details including university, department, year of study and gender. The second part (Part B) was consisted with 10 questions about self-medication.

Participants were from, University of Peradeniya, University of Sri Jayewardenepura, University of Ruhuna, University of Jaffna and Kotelawala

Defense University. Stratified random sampling was used to select the participants from each department of Medical Laboratory Science, Pharmacy, Nursing, Physiotherapy and Radiotherapy. Simple random sampling was employed for the final selection of the participants through answered google forms. The sample size was determined by the single population proportion formula. Participants who belong to any ethnic group or race were allowed to participate in this study regardless of their gender group. All participants who gave their consent were included in the study. Participants who did not give approval and who were not willing to supply information were excluded from our study. The data were analyzed by the summary of the google form.

Result and Discussion

A total number of 371 undergraduates were participated in this study. Out of the total participants, 73.85% were female and 26.14% were male.

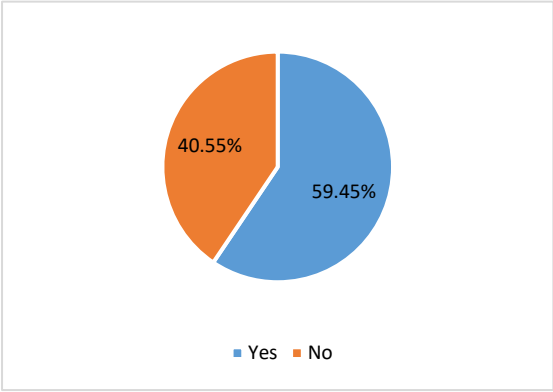

Figure. 1 Prevalence of self-medication

This above pie chart (Figure 1) shows the percentage of people who have taken SM during last two months. According to this the prevalence of self-medication is 59.45%.

SM has now become a global phenomenon in the present world. According to the research studies done within past five years, it has found that the prevalence of SM among university students is high. For an example (2020), the general prevalence of SM among university students was 70.1%. Majority of them were medical students (97.2%) [18]. the prevalence of SM in our study was found to be 59.45%. A similar prevalence has been reported in the study conducted among university students of Faculty of Medicine, Ain-Shams University, in Egypt which was 55% [19].

However, difficulties were encountered when comparing the prevalence of SM among undergraduate university students in the national perspective due to lack of research conducted in Sri Lanka on this aspect.

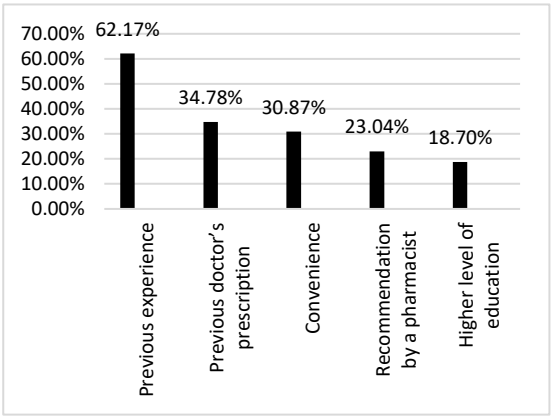

Fig 2. Reasons for using self-medication

According to figure 2, our study denoted that the most common reasons for SM as previous experience (62.17%) followed by previous doctor's prescription (34.78%), convenience (30.87%), recommendation by a pharmacist (23.04%) and higher level of education (18.70%).

According to a study conducted in Bangladesh (2018), most common causes for SM were indicated as minor diseases (73.9%) and previous experience (71.4%) [20]. Then, based on an Ethiopian study (2016), minor illnesses (44.1%) and poor-quality health care routine services (27.1%) were main reasons for SM [28]. Further, two most frequent reasons found in Nigerian study (2018) for SMPs were prior knowledge and previous experience (67.9%) and mild illnesses (55.8%). [29]

Therefore, it can be considered that treatment based on previous experience may result in misdiagnosis and incorrect choice of drugs, since diseases may share similar symptoms.

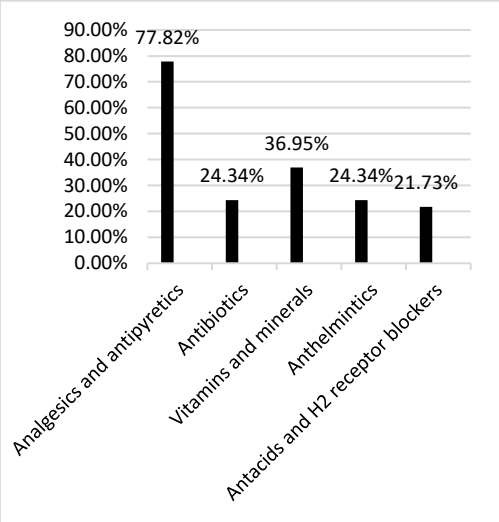

Fig 3. Class of medicines used as self-medication

Figure 3 shows that, analgesics was the most used class of drugs (77.82%) among Allied Health Science undergraduates of Sri Lanka. Vitamins and minerals were the secondly highest used classes of drugs which is 36.95% of total respondents. Some of the other types of drug classes were Antibiotics (24.34%), Anthelmintics (24.34%), Antacids and H_2 receptor blockers (21.73%).

These results were similar to a south Indian study that showed, usage of analgesics (65%) and antipyretics (71%) in high percentages as commonly used drug classes [21]. Further, study conducted among Jordanian university students in 2019, the majority (56.3%) were observed with using painkillers. [22]

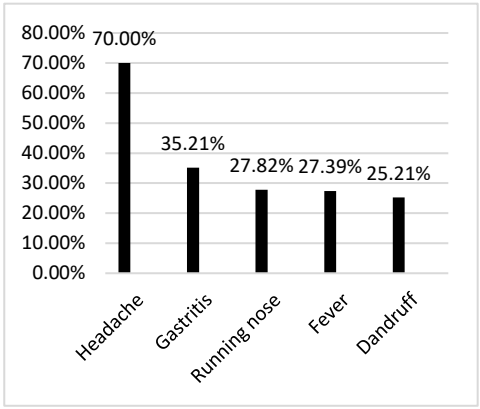

Fig. 4 Health conditions to which Self-medications were used

The most common health condition which the participants were compelled to use self-medication was headache which is 70% following gastritis (35.21%), running nose (27.82%), and fever (27.39%) and dandruff (25.21%). (Figure 4)

According to an Ethiopian study conducted in 2007 and Palestine study conducted in 2010, it was found that the most common ailments for which SM used were headache [19] [23]. Further, International survey in Department of Public Health, Marmara University School of Medicine and School of Nursing, Istanbul, Turkey indicated that SM was most taken for fever, headache, ingestion, and sore throat conditions [24].

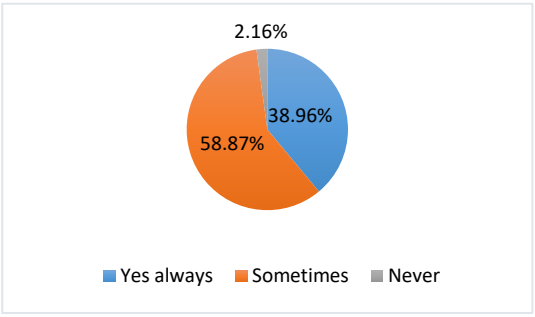

Fig. 5 Instructions read prior to self-medication checked for instructions

When looking for information about respondents who read the instructions on the package before taking SM, according to the figure 5, many respondents have probably checked the instructions on the package and 2.16% of them had never checked the instructions.

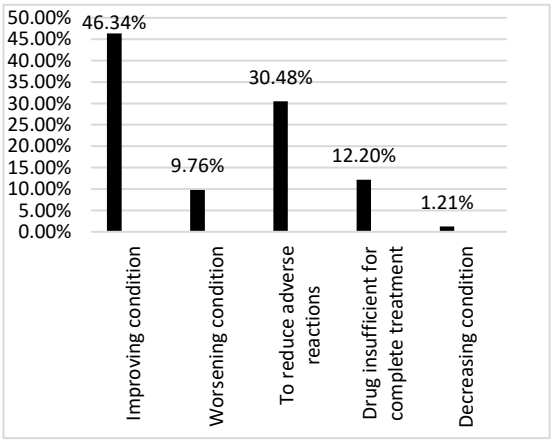

Fig. 6 The reason for changing self-medication

According to the figure 6, the most common reason for changing the dose of medication during self-

medication practices were due to improving conditions of the symptoms (46.34%) and to reduce adverse drug reactions (30.48%) that would arise due to SMPs.

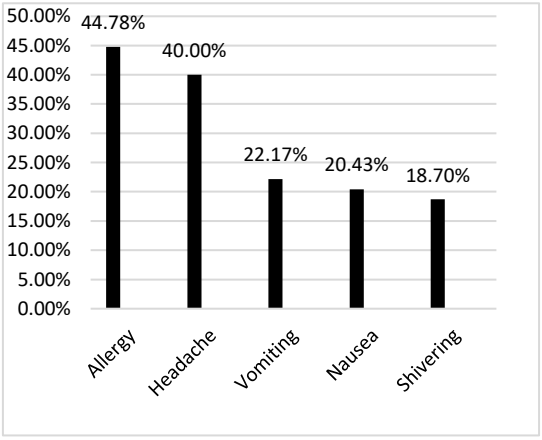

Fig. 7 Common adverse reactions

Some of the most common adverse drug reactions that had arisen due to SM according to the figure 7, were allergy (44.78%), headache (40.00%), vomiting (22.17%), and nausea (20.43%), shivering (18.7%). Furthermore, some other studies also have shown that adverse drug reactions such as antibiotic resistance, hypersensitivity and many other problems were caused due to some drugs used in SM. For example, according to a review article written by D.Bennadi (2013) on adverse effects that were caused due to use of allotropic drugs for SM, at Sri Siddhartha Dental College and Hospital, Karnataka in India, has shown that antibiotic resistance, skin problems and hypersensitivity were mainly caused in addition to allergic conditions [25]. Therefore, it is mandatory to maintain pharmacovigilance data to prevent adverse drug reactions and improve the quality of life of the patients.

Conclusion

The prevalence of self-medication practices among Allied Health Science undergraduates in Sri Lanka was determined as 59.45%. The majority of the undergraduates used analgesics and antipyretics as the SM drugs due to their previous life experience. Headache was the main health condition that undergraduates compelled to use SM and occurrence of allergies (44.78%) was reported as the commonest adverse drug reaction.

Recommendation

Recommend for government, National Medicines Regulatory Authority (NMRA) and other relevant authorities to prepare, implement policies and programs to make both the public and relevant health care stakeholders aware about the selling, advertising, and the safe use of self-medication to prevent the adverse drug reactions that may occur through that.

Declarations

A. Study Limitations

As the respondents were given the pretested questionnaire in the form of a google form, some defects had been occurred by some respondents when filling the google forms which cause certain issues when collecting data for the research.

B. Acknowledgements

Authors would like to express sincere gratitude to Prof. Menik Hettihewa, Dean of faculty of Health Sciences, CINEC Campus, Malabe and to all the other academic, non-academic staff members of Department of Pharmacy and Pharmaceutical Sciences, Faculty of Health Sciences, CINEC Campus, Malabe and Colombo, Sri-Lanka.

C. Funding source if any

None.

D. Conflict of Interests

The authors declare that there is no any conflict of interests

E. Human and Animal Related Study

None

F. Ethical Approval

This study was conducted after obtaining the ethical approval from the Ethical Review Committee of CINEC Campus, Malabe.

G. Informed Consent

Prior to gaining each volunteer's consent, the aim of the study and their participation in it were clearly stated.

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Original Article

Optimizing Cement Quarry Dust Ratio in Concrete Asphalt Using for Industrial Purposes

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Abstract

Scarcity and the high cost of natural river sand due to government restrictions are the major problems for the construction industry. It was observed that cement quarry dust ratio is higher in quarry dust concrete mixes compared to conventional concrete mixes used for highway projects due to the effects influenced by shape, surface & content of micro fines of quarry dust. In this study, the cement quarry dust ratios were optimized to obtain the optimum strength, workability & to use quarry dust concrete using for industrial purposes. Workability, compressive strength tests were conducted on basic three quarry dust concrete grade mixes which vary quarry dust ratio percentage from 0.41 to 0.43 according to the British design approach. Workability of designed M20, M30 & M40 quarry dust concrete mixes has shown lower workability & compressive strengths on M20 0.41 and 0.42 grade quarry dust concrete mixes were higher compared to conventional concrete mixes. Cost analysis indicates that the percentage of cost reduction on optimized cement quarry dust ratio concrete mixes stands between 27% to 31% than conventional concrete mixes. It can be concluded that M20 – 0.41 and M20 – 0.42 QD concrete mixes can be used for industrial purposes as a replacement for conventional concrete mixes & using superplasticizer, M30 grade quarry dust concrete mixes and M40 – 0.41 quarry dust concrete mix can be used for industrial purposes with enhancing the workability and compressive strength than conventional concrete mixes. Further, it is concluded that optimized cement quarry dust ratio concrete mixes are cost-effective compared to conventional concrete mixes.

Keywords: Concrete, Quarry dust, Compressive strength

Introduction

Demand for concrete is increasing sharply due to the ongoing boom of the building sector & other construction sectors in the world. According to the Hygius E. Opara *et al*., (2018) concrete is produced 15 billion tons in the world annually & this production volume consumes a huge number of natural resources for cement & aggregate production.

Due to the sand mining activities, changing the shape & form of the channels, degrading the quality of drinking water, erosion of the river banks, enlarging river mouths can happen. These changes lead to intrusion of saline water of the sea & it will be a threat to the drinking water, bridges & nearby structures. Government restrictions & scarcity of the river sand affect the price of the sand & it increases the cost of construction. As a solution for these problems, replacements of natural sand are used as fine aggregates in concrete.

For the express highways projects in Sri Lanka quarry dust is the main material using for concrete asphalts & all the prior approvals are taking for the quarry dust. So, in Sri Lanka quarry dust is manufactured purposely to use as a replacement for natural sand.

According to RWCN Rajapaksha and HP Sooriyaarachchi (2009) quarry dust has an angular shape with a rough surface texture compared to sand, angular shape creates a more void volume. Due to the higher amount of micro fines water absorption of QD concrete mixes is higher than to the NS concrete mixes. So, because of these reasons, it has been found cement quarry dust ratio is higher in concrete asphalts using for industrial purposes. According to Eng. Kapila Peiris, Project Manager of Olympus Construction (Pvt) Ltd in proposed central expressway project, cement

quarry dust ratio in QD concrete mixes is higher compared to NS concrete mixes. High cement quarry dust ratio is not economical for mass construction projects & it damages the environment & caused air pollution due to higher cement production.

In this study aims to identify the optimum cement quarry dust ratio in concrete asphalt using for industrial purposes. The main objectives of this study are to study whether quarry dust satisfies the requirements & the recommendations of the BS standard, to identify the strength & workability of prepared QD concrete mixes compared to control QD & NS concrete mix samples.

Methodology

A. Materials

Following materials were used for this study.

1. Cement: Ordinary Portland cement (Strength class 42.5 N) which is compatible with natural sand, quarry dust & sea sand complying with BS EN 12620:2013 was used.
2. Quarry dust: Quarry dust was collected from the local construction site at the respective quarry dust crushing plant. Bulk relative density of quarry dust was taken as 1720 kg/m^3, specific gravity as 2.54 & water absorption as 1.20%.
3. Coarse aggregate: Natural granite aggregate, 20mm aggregate size was taken as the course aggregate which has the density of 2700 kg/m^3, specific gravity as 2.60 & water absorption as 0.45%.
4. Water: Adequate consumable water is used for the concrete mix proportions following the BS 3148 standard.
5. Admixtures: Although for QD concrete mixes Super-plasticizers have been used commercially to increase the workability of quarry dust concrete, for this study any admixtures were not used.
6. Mix designs: For quarry dust as fine aggregate in concrete production there is no standard method for designing. According to R.Ilangovana *et al*., (2008) using BS standard, NS concrete mixes were designed first & then QD concrete mix was designed.

Grade of concrete	**Mix design method**	**Mix proportion**	**Mix proportions (By weight)**
M20	British	M20 - 0.41	0.96:3.47:4.05
		M20 - 0.42	0.87:3.56:4.05
		M20 - 0.43	0.79:3.64:4.05
M30	British	M30 - 0.41	0.79:3.36:4.05
		M30 - 0.42	0.71:3.44:4.05
		M30 - 0.43	0.63:3.52:4.05
M40	British	M40 - 0.41	0.76:2.87:3.37
		M40 - 0.42	0.69:2.94:3.37
		M40 - 0.43	0.62:3.01:3.37

Table I: Designed concrete mixes &their proportions

B. Test Procedure:

1) Particle size distribution of the quarry dust

Sieve analysis test was done using quarry dust & natural sand according to the BS 882 standard. BS sieves were arranged in order (10mm, 5mm, 2.36mm, 1.18mm, 600µm, 300 µm, 150 µm). Using the sieve sizes & percentage mass passing data a graph was plotted on a semi-log graph sheet as shown in fig.1.

2). Workability

Slump test was done using the fresh quarry dust concrete & it was filled into the slump cone in three stages & compacted well. Finally, slump was measured.

3). Compressive Strength Test

For the compressive strength test, each above-mentioned mix proportions of quarry dust fresh concrete were filled to 150 × 150 × 150mm moulds. Then cured hardened concrete cube specimens were tested & using maximum axial load & load acting area compressive strength was calculated.

$$\sigma = \frac{F}{A}$$

Where,

σ = Compressive strength (MPa)

F = Maximum axial load applied on the cube (N)

A = Area of the cross-section of the cube (mm^2)

RESULTS AND DISCUSSION

A. Properties of Raw Materials:

1. Particle Size Distribution of the Quarry Dust

According to the gradation curve of quarry dust with upper & lower boundaries, it can be seen that the quarry dust sample fulfilled the recommendations of BS 882 for particle size distribution for fine aggregates.

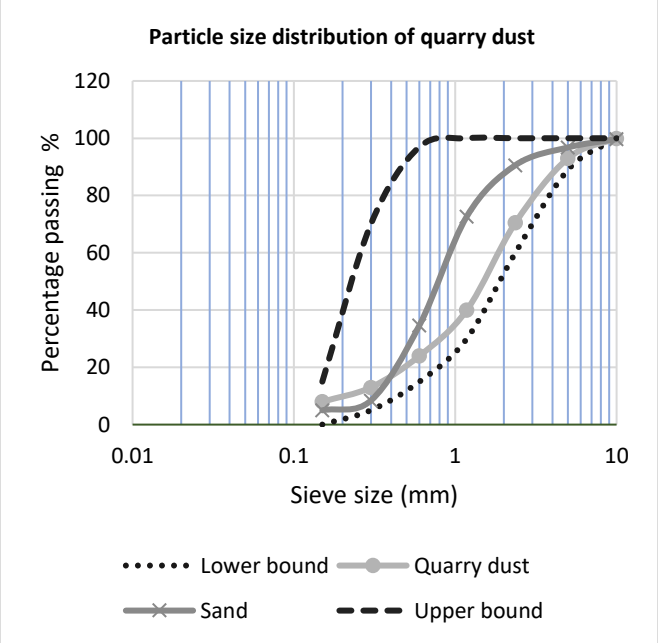

Fig. 1: Practical size distribution of quarry dust

Mix proportion	W/C ratio	QD/C ratio	Slump (mm)	Compressive strength (MPa)		
				7 days	14 days	28 days
M20 - 0.41	0.66	3.61	60	17.71	19.98	25.3
M20 - 0.42	0.60	4.09	55	17.35	21.02	24.9
M20 - 0.43	0.55	4.60	15	15.27	19.33	20.3
M30 - 0.41	0.52	4.25	25	17.62	21.68	26.73
M30 - 0.42	0.46	4.85	20	14.97	17.81	22.95
M30 - 0.43	0.41	5.59	10	16.43	21.46	25.97
M40 - 0.41	0.43	3.78	25	19.74	25.69	31.89
M40 - 0.42	0.39	4.26	15	18.04	19.59	24.37
M40 - 0.43	0.35	4.85	5	11.99	13.20	19.02

Table II : Details of the concrete mix proportions & test results

B. Fresh properties of concrete:

1. Workability of M20, M30 & M40 grade QD concrete mixes

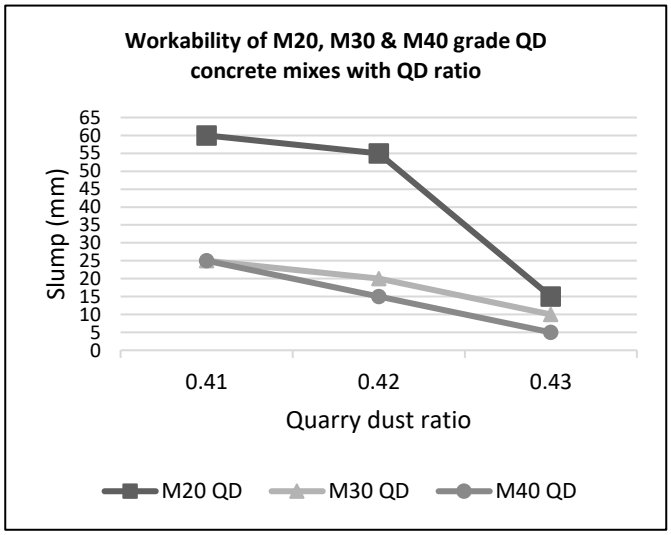

Fig. 2: Workability of M20, M30 & M40 grade QD concrete mixes with QD ratio

M20 – 0.41 QD concrete mix which has the highest water-cement ratio in M20 grade QD concrete mixes showed the highest workability compared to other M20 concrete mixes. A slight reduction was observed in M20 – 0.42 QD mix & sharp reduction was observed in M20 – 0.43 mix.
M30 – 0.41 QD concrete mix which has the highest water-cement ratio in M30 grade QD concrete mixes showed the highest workability compared to other M20 concrete mixes. A slight reduction was observed in M20 – 0.42 QD & M20 – 0.43 mixes.
M40 concrete mixes had the lowest water-cement ratios & higher cement quarry dust ratios & M40 mixes showed the lowest workability compared to other M20 & M30 QD mixes. M40 – 0.43 showed 5 mm slump & it was an 80% sharp decrease than M40 – 0.41 mix. M40 NS control concrete mix has shown a 40 mm slump value & it was a 37.5% increment than M40 – 0.41 quarry dust concrete.

According to R.Ilangovana et *al*., (2008) M20 – 0.40 QD concrete mix with superplasticizers has shown 80mm workability, M30 – 0.38 QD mix has shown 70mm workability & M40 – 0.38 QD mix has shown 30mm workability.

The angular shape, rough surface texture & high silt content quarry dust with the highest cement content could be affected to workability QD concrete mixes when increased the quarry dust proportion.

C. Hardened Properties of Concrete:

1. Compressive strengths M20 grade QD concrete mixes.

It can be observed that the M20 – 0.41 QD concrete mix showed increment at all ages compared to the NS control concrete mixes. M20 - 0.41 QD concrete mix showed 17.71 N/mm^2, 19.98 N/mm^2 & 25.3 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 13.5 N/mm^2, 18 N/mm^2 & 24 N/mm^2 strength values.

It can be seen that the compressive strength values of M20 – 0.42 QD mixes were lower than M20 – 0.41 QD concrete mixes although it showed increment at the all-ages compared to the NS control concrete mix. M20 - 0.42 QD concrete mix showed 17.35 N/mm^2, 21.02 N/mm^2 & 24.9 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 13.5 N/mm^2, 18 N/mm^2 & 24 N/mm^2 strength values.

M20 – 0.43 was the concrete mix that had the maximum quarry dust ratio in M20 grade QD mixes. It can be observed that M20 – 0.43 QD concrete mix showed increment at 7 & 14 days. But compressive strength at 28 days was reduced than NS control concrete. M20 - 0.43 QD concrete mix showed 15.27 N/mm^2, 19.33 N/mm^2 & 20.3 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 13.5 N/mm^2, 18 N/mm^2 & 24 N/mm^2 strength values.

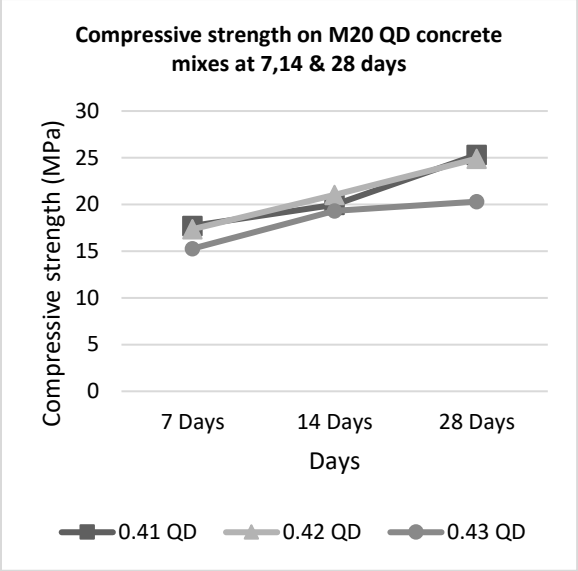

Fig. 3: Compressive strength of M20 QD concrete mixes at 7, 14 & 28 days.

2. Compressive strengths M30 grade QD concrete mixes.

It can be observed that the M30 – 0.41 QD concrete mix showed a reduction in compressive strength at all ages compared to the NS control concrete mixes. M30 - 0.41 QD concrete mix showed 17.62 N/mm^2, 21.68 N/mm^2 & 26.73 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 18 N/mm^2, 27 N/mm^2 & 32 N/mm^2 strength values.

M30 - 0.42 QD concrete mix showed 14.97 N/mm^2, 17.81 N/mm^2 & 22.95 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 18 N/mm^2, 27 N/mm^2 & 32 N/mm^2 strength values.

M30 – 0.43 was the concrete mix that had the maximum quarry dust ratio in M30 grade QD mixes. It can be observed that M30 – 0.43 QD concrete mix showed an increment than M30 – 0.42 but lower than M20 – 0.41 QD concrete & NS control concrete mixes. M30 - 0.43 QD concrete mix showed 16.43 N/mm^2, 21.46 N/mm^2 & 25.97 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 18 N/mm^2, 27 N/mm^2 & 32 N/mm^2 strength values.

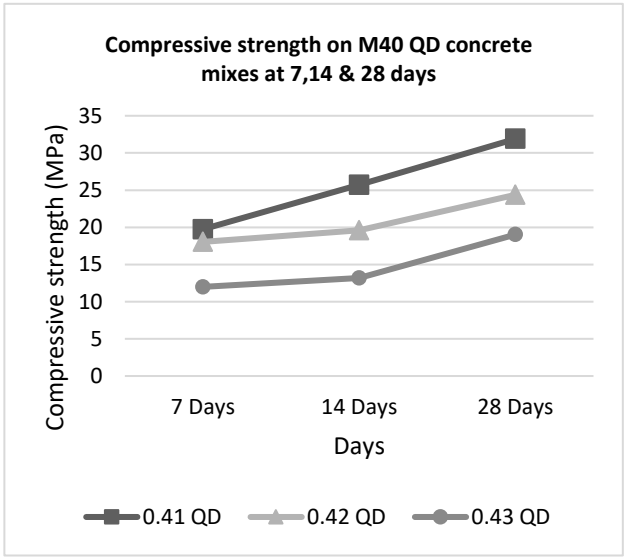

Fig. 4: Compressive strength of M30 QD concrete mixes at 7,14 & 28 days.

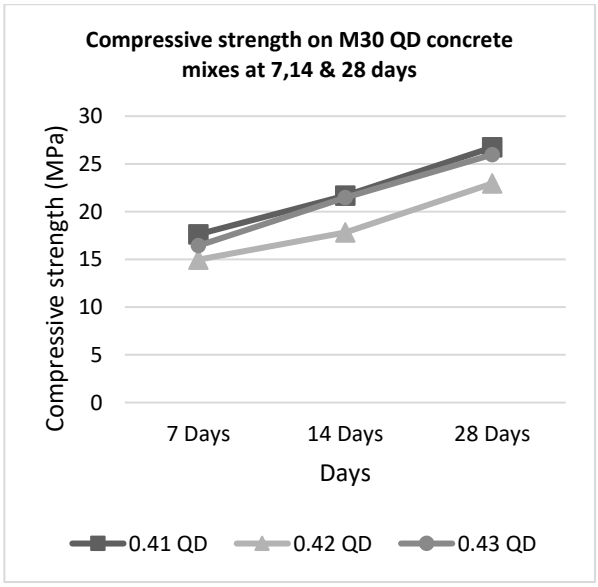

Fig. 5: Compressive strength of M40 QD concrete mixes

3. Compressive strengths M40 grade QD concrete mixes.

M40 – 0.41 QD concrete mix showed a reduction in compressive strength at the all-ages compared to the NS control concrete mixes as shown in fig. 5.

M40 - 0.41 QD concrete mix showed 19.74 N/mm^2, 25.69 N/mm^2 & 31.89 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 26 N/mm^2, 36 N/mm^2 & 46 N/mm^2 strength values.

It can be seen that the compressive strength values of M40 – 0.42 QD concrete were lower than M40 – 0.41 QD concrete mix with the increment of quarry dust ratio. M40 - 0.42 QD concrete mix showed 18.04 N/mm^2, 19.59 N/mm^2 & 24.37 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 26 N/mm^2, 36 N/mm^2 & 46 N/mm^2 strength values.

M40 – 0.43 QD mix was the concrete mix that had the maximum quarry dust ratio in M40 grade QD mixes. It can be observed that the M40 – 0.43 QD concrete mix showed the lowest compressive strength values compared to the other two M40 grade QD concrete mixes. M40 - 0.41 QD concrete mix showed 11.99 N/mm^2, 13.2 N/mm^2 & 19.02 N/mm^2 compressive strength value at 7, 14 & 28 days where as control concrete mix showed 26 N/mm^2, 36 N/mm^2 & 46 N/mm^2 strength values.

Overall, the results indicate that the M20 QD mixes have shown the highest compressive strength values among the quarry dust mixes. The reason can be explained by the higher rate of increment of compressive strength on M20 QD

Concrete mixes as the accelerated cement hydration due to the micro fines of quarry dust. Quarry dust accelerates the formation of cement hydration at early stages. For the higher

Increment of compressive strength on M20 QD concrete mixes, the filling effect of micro fines in quarry dust was mainly caused. Because micro fines of quarry dust filled the voids of the concrete mix than natural sand & it enhanced the density in microstructure concrete. Moreover, the specific gravity & intrinsic strength of quarry dust is higher than natural sand particles which might increase the compressive strength of the concrete mixes. The rough surface texture of the quarry dust particles also supported to bond better between

aggregates and the cement paste & increased the compressive strength of M20 mixes.

M30 – 0.42 QD mix showed the lowest compressive strength value compared to other M30 QD concrete mixes. Usage of Insufficient & unsuitable cement amount when mixing the concrete or improper compaction due to the human errors and poor interlocking between cement paste & aggregates particles could be caused to the reduction of compressive strength on M30 – 0.42 QD mix.

M40 QD mixes have shown lowest compressive strength values compared to the other QD mixes. Due to a large number of micro fines, cement paste became not enough to bond aggregates particles in the concrete mix properly. So, when the quarry dust ratio was increased compressive strength of the M30, 40 QD mixes slightly decreased.

D. Cost analysis of QD concrete mixes:

The significance of this dissertation study was to optimize the cement quarry dust ratio & cost-effectiveness in construction. Quantity of cement, quarry dust & coarse aggregates were calculated for $1m^3$ volume of each QD concrete mix by multiplying the weight with the per-unit price of the material. The total cost of the M20 – 0.41 QD concrete mix is LKR 11382.63 & when compared to the M20 grade 20mm aggregate concrete mix, it is LKR 4218.93 cost reduction. Following this cost calculation method cost for other quarry dust mixes also were calculated. According to the above results, it can be seen that when cement percentage was decreased the percentage of reduction increased. The lower price of quarry dust materials compared to the natural sand & cement reduction was influenced by the increment of cost reduction in quarry dust concrete mixes.

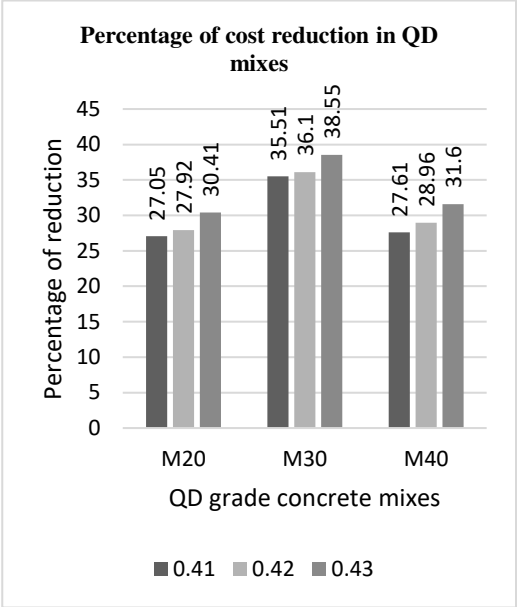

Fig. 6: Percentage of cost reduction in QD mixes

Conclusion

The difference of the particle size distribution between natural sand quarry dust is shown in Fig. 4.1, excessive content of micro fines & angular rough surface texture of quarry dust particles which tends to decrease the workability of quarry dust concrete mix due to the increment of friction between cement paste and aggregates were the major facts to decrease the workability of QD concrete mixes compared to NS concrete mixes.
According to the results from workability, it can be concluded that M20 QD concrete mixes are suitable for structural uses according to Indian standards.
If any admixtures are used for the M30, 40 QD concrete mixes to enhance the workability as mentioned in the past research work of R.Illangnova *et al*., (2008), compressive strength also can be increased.

According to the results compressive strength values of M20 concrete mixes were higher than NS concrete mixes. These mixes can be used as a replacement for natural sand concrete for industrial purposes. Although the compressive strength of M20 – 0.41 QD slightly exceeded the 20 MPa margin level, this mix cannot use for industrial purposes with this water-cement ratio should be

changed to increase the workability of the mix. Then it will be mainly influenced by the higher increment of compressive strength.

According to the results, cost of M30 & M40 QD concrete mixes were lower than NS concrete mixes. The main fact for the reduction of compressive strength value was the lower workability & these mixes have shown better compressive strength values without any admixtures which used enhanced the workability of concrete mixes. It is recommended to use superplasticizer admixture to enhance the workability of the mixes & with proper compaction and better interlocking between cement paste and aggregates which will increase the compressive strength of the QD concrete mix series to use as a replacement of NS concrete mixes for industrial purposes.

In QD concrete mixes which were optimized for cement quarry dust ratios, the percentage of cost reduction stand between 27% to 31% mixes & these mixes are cost-effective compared to conventional concrete mixes.

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Original Article

Phytochemical Analysis and Evaluation of *In-Vitro* Antioxidant Activity of Bark Extracts from *Madhuca longifolia* (Madhu) and *Ficus racemosa* (Attikka) Grown in Sri Lanka

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Abstract

Madhuca longifolia (Maddhu) and Ficus racemosa (Attikka) are well known medicinal plants which have been valued for decades in Sri Lankan Ayurvedic medicine. This research was aimed to study the phytochemical analysis and evaluate *in-vitro* antioxidant activity of two solvent extracts (70% aqueous acetone and 80% aqueous methanol) obtained from each bark of selected plants. The crude extracts were prepared by steeping the dried powder in each solvent overnight in the dark conditions. Phytochemical screening of crude extracts was performed. *In-vitro* radical scavenging activity and antioxidant activity were evaluated by using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay and ferric reducing antioxidant power (FRAP) assay. The results of phytochemical analysis revealed the presence of alkaloids, phenolics, flavonoids, carbohydrates, proteins and saponins in both extracts obtained from *M. longifolia* while revealing the presence of phenolics, flavonoids, carbohydrates, alkaloids, tannins in both bark extracts obtained from *F. racemosa*. Radical scavenging activity of 80% aq. methanol and 70% aq. acetone extracts obtained from bark of *M. longifolia* were determined as 25.4±0.1 and 23.1±0.4 mmol Trolox equivalents/100 mg dry weight of bark of *M. longifolia* (DW) and antioxidant capacity of 80% aq. methanol and 70% aq. acetone extracts were 42.6 ± 0.7 and 38.0 ± 1.1 mmol Fe (ll) equivalents/100 mg DW of the bark. Radical scavenging activity for two different extracts obtained from bark of *F.racemosa* were as 18.6 ± 0.3 (80% aqueous methanol) 20.2 ± 0.7 (70% aq. acetone) mmol Trolox equivalents/100 g DW of bark. Antioxidant capacity by FRAP assay for the two different extracts of *F. racemosa* were 28.5 ± 0.4 (80% aq. methanol) and 32.8 ± 1.6 (70% aq. acetone) mmol Fe (II) equivalents/100 g DW of the bark. It was concluded that the presence of remarkable *in-vitro* antioxidant activity of two different plant extracts were observed while significant antioxidant activity was showed by 80% aq. methanol extract of *M. longifolia*.

Keywords- Antioxidant activity, Ficus racemosa, Madhuca longifolia, phytochemical analysis,

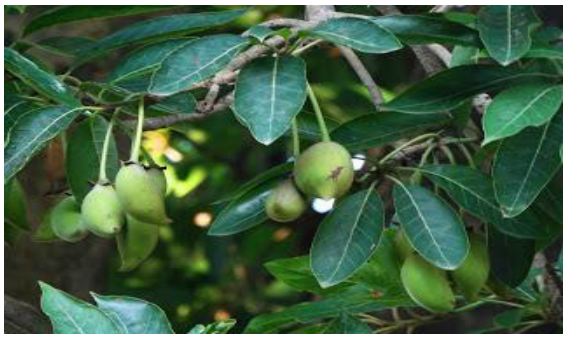
Introduction

Nowadays, attention is being focused on the development of herbal products using natural biomaterials, which can overcome the apparent drawbacks of synthetic chemicals. Even though various synthetic chemicals are being used in many formulations as antioxidants, they have limited use due to their potential toxicity and association with multistage process of carcinogenesis in humans [1]. Researches have been shown that these active synthetic molecules may adversely affects the human skin through self-inducing reactive oxygen species. Hence, to overcome those side effects, researches are focused on formulation of novel products using natural biomaterials such as naturally occurring antioxidants namely, ascorbic acid, alpha carotene, vitamin E and A, flavanone and flavones etc, which have the ability to donate electrons thereby prevent free radical chain reactions. Therefore, various compounds present in plant extracts with ability to reduce oxidative damage can also be helpful in improving the efficacy relating to continuous action of herbs on human skin [2].

Many research studies have been successfully carried out worldwide in order to investigate the potential agents from various medicinal plants and as well as to formulate novel herbal products using natural products [1]. Medicinal plants are being effective source of both traditional and modern medicines which are useful for primary healthcare,

as they have potent pharmacological activity since prehistoric times. Medicinal plants synthesize different bioactive compounds for functions including defense against insects, fungi diseases and herbivorous mammals and rich source of medicines [3]. Because of the less side effects, efficacy and safety and the origin of medicinal plants, herbal medicine is being developed both in developing and developed countries since few decades.

Madhuca longifolia commonly known as Mahua in Sinhala, belongs to the family Sapotaceae is a medium to large sized deciduous tree (Figure 1a). They are distributed in south Asian countries such as India, Sri Lanka and Nepal. Mahua grows widely under dry topical and sub topical climate conditions and can be found in forests, revenues and private lands. A various parts of *M. longifolia* are used in traditional and folklore system of medicine and known as universal panacea of ayurvedic medicine. The bark of Mahua is used to treat diabetics, ulcers, rheumatism, tonsillitis and bleedings. Mahua oil is traditionally used in skin diseases, rheumatism, headache and laxative, [4]. The flowers of Mahua are used as cooling agent, astringent and also it is used to treat acute and chronic tonsillitis, aphrodisiac, pharyngitis and bronchitis [4]. The leaves are the major component of Mahua tree that can be used as wound healing hepatoprotective, antimicrobial, astringent, and used for bronchitis, cephalgia and Cushing's disease. The roots of Mahua are traditionally used as anti-inflammatory, antioxidant, antipyretic and also root powder is used for diarrhoea and other chronic fluxes [5].



(a)

(b)

Figure 1: Images of (a) *Madhuca longifolia* plant (b) *Ficus racemosa* plant

Ficus racemosa plant which is usually known as cluster fig tree belongs to the family Moracea. It is commonly known in Sri Lanka as "attikka" which is grown all over the country. It is one of the members of the sacred trees to be planted around temples. This plant is used in traditional medicine systems such as Ayurveda, Unani, Sidda and also homeopathy medicine system for the treatment of various disorders [6]. *F. racemosa* is an ever green, moderate to large sized spreading tree with smooth, grey bark and it is about 20 m tall often with areal roots (Figure 1b) [7]. Though there are scientific reports found in the similar work carried out internationally, a very few research studies carried out in Sri Lanka were found in the literature. Therefore, this research was aimed to study the phytochemical analysis, total phenolic contents and evaluate *in-vitro* antioxidant activity of different solvent extracts obtained from bark of *F. racemose* and *M. longifolia.*

Materials And Methods

Plant materials and chemicals

Bark of *F. racemosa* was collected from Kamburupitiya in Matara district and the bark of *M. longifolia* was collected from Beliattha in Hambanthota district (Southern province, in Sri Lanka) in 2020. The plant material of *F. racemosa* was authenticated at the National Herbarium, Peradeniya**,** in Sri Lanka while the plant material of *M. longifolia* was authenticated at Pinnaduwa herbarium in Galle Sri Lanka.

The chemicals of 2-2-diphenyl-1-picrylhydrazyl (DPPH), TPTZ (2,4,6-tripyridyl-s-triazine), Trolox, conc. HCl, conc. H_2SO_4, $FeCl_3.6H_2O$,

$Fe(II)SO_4.7H_2O$, ethanol, methanol, acetone and hexane were purchased from Sigma Aldrich local agencies in Sri Lanka.

Preparation of the plant extracts

The crude extracts of 70% aqueous acetone and 80% aqueous methanol of each plant were prepared according to the published method [8] with slight modifications. Briefly, ground powder of oven dried barks was steeped in the solvent (300 mL) separately in Scott Duran bottles with occasional shaking (GEMMYCO shaker, Lab shaking incubator, model:IN-666) for 24 hours in the dark conditions at room temperature. After 24 hours, these extracts were filtered using four layers of muslin cloth and were concentrated under the vacuum using the rotary evaporator (HAHN HS-2005S-N) below 65 ˚C. They were subjected to freeze drying (freeze dryer-BIOBASE BK-FD10PT) until a constant weight was gained.

Qualitative testing for phytochemical analysis

The bark extracts obtained from selected plants were screened qualitatively according to the method published [3], [9] to detect the presence of phytochemicals having interest in therapeutically and pharmacological applications such as carbohydrates, proteins, alkaloids flavonoids, phenolic compounds, saponins and terpenes.

Determination of total phenolic content

The total phenolic contents of the bark extracts were determined by Folin-Ciocalteu assay colorimetric method [8] and the results were expressed as mg Gallic Acid Equivalent (GAE) to 100 g dry weight of bark.

Evaluation of in-vitro radical scavenging activity

In-vitro radical scavenging activity of each extract was determined using the 2, 2,-diphenyl-1-picrylhydrazyl (DPPH) assay according to a published method [8] and the results were expressed as mmol Trolox equivalents to 100 g dry weight of the bark.

Evaluation of in-vitro antioxidant activity

In-vitro antioxidant activity of each extract was determined using the ferric reducing antioxidant power (FRAP) assay according to a published method [8]. The antioxidant activity was calculated using the standard calibration curve of Trolox and expressed as mmol Fe (II) equivalents/100 g DW of the bark.

Statistical analysis

All experimental measurements were carried out in triplicates and the results were expressed as the mean ± Standard Deviation. The results were analysed by multiple comparison one-way ANOVA at Turkey 95% and independent sample t-test using the SPSS 21 software. At ($p<0.05$), values were considered significantly different at 95% level of confidence.

Result

Phytochemical screening

The results of preliminary phytochemical analysis revealed the presence of alkaloids, phenolics, flavonoids, carbohydrates, proteins and saponins in the both extracts obtained from *M. longifolia* while revealing the presence of phenolics, flavonoids, carbohydrates, alkaloids, tannins in both bark extracts obtained from *F. racemosa*.

Total phenolic content

The 80% aq. methanolic bark extract of *F. racemosa* had total phenolic content of 4414.2 ± 117.4 mg GAE/100g DW of the bark and 70% aqueous acetone bark extract of *F. racemosa* had total phenolic content of 5195.4 ± 132.9 mg GAE/100g DW. The 80% aq. methanolic bark extract of *M. longifolia* had total phenolic content of 7646.9±179.2 mg GAE/100g DW of the bark and 70% aqueous acetone bark extract of *M. longifolia* had total phenolic content of 7551.8±26.6 mg GAE/100g DW (Table 1).

Table 1: Total phenolic contents of different solvent extracts from selected plants.

Solvent Type	TPC (mg GAE/100 g DW ± SD)	
	M. longifolia	*F.racemosa*
70% aq. Acetone	7551.8±26.6[a]	5195.4 ± 132.9[c]
80% aq. Methanol	7646.9±179.2[b]	4414.2 ± 117.4[d]

Results are expressed as M±SD: Mean ± Standard Deviation. Means followed by different letters in a column and a raw are significantly different ($p<0.05$).

In vitro antioxidant activity of the extracts obtained from

Radical scavenging activity of 80% aq. methanol and 70% aq. acetone extracts obtained from bark of *M. longifolia* were determined as 25.4±0.1 and 23.1±0.4 mmol Trolox equivalents/100 mg dry weight of bark of *M. longifolia* (DWM) and antioxidant capacity of 80% aq. methanol and 70% aq. acetone extracts were 42.6 ± 0.7 and 38.0 ± 1.1 mmol Fe (ll) equivalents/100 mg DW of the bark. Radical scavenging activity for the two different extracts obtained from bark of *F.racemosa* were as 18.6 ± 0.3 (80% aqueous methanol) 20.2 ± 0.7 (70% aq. acetone) mmol Trolox equivalents/100 g DWF of bark. Antioxidant capacity by FRAP assay for the two different extracts of *F. racemosa* were 28.5 ± 0.4 (80% aq. methanol) and 32.8 ± 1.6 (70% aq. acetone) mmol Fe (II) equivalents/100 g DW of the bark (Table 2).

Table 2: In-vitro antioxidant activities of different solvent extracts from selected plants.

Solvent Type	Radical Scavenging activity (mmol Trolox/100 g DW of bark)		Antioxidant activity (mmol Fe(II) equivalents/100 g DW of the bark)	
	M. longifolia	*F.racemosa*	*M. longifolia*	*F.racemosa*
70% aq. Acetone	23.1±0.4[a]	20.2 ± 0.7[c]	38.0 ± 1.1[e]	32.8 ± 1.6[g]
80% aq. Methanol	25.4±0.1[b]	18.6 ± 0.3[d]	42.6 ± 0.7[f]	28.5 ± 0.4[h]

Results are expressed as M±SD: Mean ± Standard Deviation. Means followed by different letters in a column and a raw are significantly different ($p<0.05$).

Discussion

With the agreement to the results obtained in this study, it was reported that *M. longifolia* contains sapogenins, steroids, saponins, flavonoids, triterpenoids and glycosides [10]. Folin-Ciocalteu method is most widely used procedure for quantification of phenolic compounds in plant materials. This assay is based on the reduction of phosphomolybdic-phosphotungstic acid (FC) reagent to a blue complex in an alkaline solution occurs in the presence of phenolic compounds [8]. The total phenolic contents of the different extracts were evaluated by using this method with reference to the standard curve equation: $y = 0.001x$, $r^2 = 0.9961$. The results obtained for the concentration of total phenolic contents were expressed as mg Gallic Acid Equivalent (GAE)/100 g dry weight (DW) of bark. *M. longifolia* showed significantly high amount of total phenolics (7646.920±179.230 mg GAE/100 mg DW of bark) than *F. racemosa* extract which may contribute for high antioxidant activity of the plant. *In-vitro* radical scavenging activity of the four different extracts were evaluated by using 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay for 1 mg/mL concentration of samples with reference to the standard curve equation: $y = 0.2635x$, $r2 = 0.9966$. The results obtained for the concentration of radical scavenging activity were expressed as mmol Trolox equivalents/100 g DW of bark. FRAP assay was a simple and speedy method which uses antioxidants as reductants in a redox colorimetric method used to determine antioxidant activity of plant materials. At low pH, ferric tripyridyltriazine complex was reduced to the ferrous (Fe^{2+}) form, which has an intense blue color with an absorption maximum at 593 nm [8]. *In-vitro* antioxidant activity of plant extracts was evaluated by using ferric-reducing antioxidant power activity (FRAP assay) with reference to the standard curve equation: $y = 0.6225x$, $r2 = 0.9976$. The results obtained for the concentration of antioxidant contents are expressed as mmol Fe (II) equivalents/100 g DW of the bark. The results of this study revealed that the 80% aq. methanol extract of *M. longifolia* bark had the highest antioxidant value for both DPPH and FRAP assay. A study was conducted to determine the antioxidant activity of methanolic extract of *M. longifolia* bark and it was evaluated by free radical scavenging activity using DPPH assay, reducing

power assay and superoxide scavenging activity compared to ascorbic acid and gallic acid and the results concluded that *M. longifolia* bark was rich in antioxidant activity [11]. A comparative study on the antioxidant activity of methanolic extracts of *Terminalia paniculata* and *Madhuca longifolia* was performed by Agrawal and the team [12]. Results had showed that both the extracts possessed significant antioxidant property but *M. longifolia* exhibited higher activity in case of DPPH and hydrogen peroxide radical scavenging [12]. Our research findings obtained for *F. racemosa* are in the agreement of the results reported in the literature. Methanolic extract of leaves and bark of *F. racemosa* had been screened for antioxidant activity based on 1-diphenyl-2-picrylhydrazil (DPPH) free radical scavenging assay. It had been found that both leaf and bark extract of *F. racemosa* contain higher scavenging activity even that of the standard BHT [13]. Another research has been conducted to study the antioxidant activity of *F. racemosa* bark using two solvents such as ethanol and water. According to the results of the research that ethanolic extract exhibited significantly higher antioxidant activity than the water extract [14].

Conclusion

The aim of this study was to evaluate antioxidant activities of different solvent extracts obtained from two plants selected namely, *M. longifolia* and *F. racemosa*. By considering the results obtained for phytochemical analysis, total phenolic, and *in-vitro* antioxidant activity of the two different solvent extracts of both plants tested, 70% aqueous acetone extract of *M. longifolia* showed significantly greatest *in-vitro* antioxidant activities among all the extracts tested.

Acknowledgement

Authors would like to express sincere gratitude to all the academic, non-academic staff members of the Department of Pharmacy, Faculty of Allied Health Sciences, University of Ruhuna, and Galle, Sri Lanka.

Conflict of interests

The authors declare that there is no conflict of interest.

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Original Article

Prevalence of primary dysmenorrhea and it's influence on the daily activities of undergraduate female students in Colombo District, Sri Lanka

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Abstract

Primary dysmenorrhea, refers to a prevalent menstrual disorder in women of the reproductive age which may interfere with the normal functioning of day-to-day activities. This study was conducted to determine the prevalence of dysmenorrhea in undergraduates and the associated influence on their usual activities. Ethical approval was obtained for the research from the Ethics Review Committee, CINEC campus. Following validation of the questionnaire, it was circulated on-line to 364 undergraduate female students, aged 18-25 years, across 5 selected non-state universities in Colombo District, Sri Lanka. According to the obtained results, the prevalence of primary dysmenorrhea was 90% (n = 309). Around 42% of the participants reported mild pain associated with primary dysmenorrhea, whereas, 53% reported moderate pain. Furthermore, a small fraction of the participants reported severe pain which affected them to complete their day-to-day activities. Recurrent symptoms associated with primary dysmenorrhea were identified as lower abdominal pain 95%, thigh pain 57%, and back pain 46% from all participants. The Chi-square test showed a significant association between primary dysmenorrhea and family history ($p < 0.001$). Moreover, frequency of occurrence of pain was significantly associated with duration of menstrual bleeding (no. of days > 5) ($p < 0.001$). Most of the respondents experience difficulty in sleeping 73% and difficulty in moving 48%. Associated methods of pain relief were consumption of analgesics 74% and bed rest 64%. Despite the significant prevalence of primary dysmenorrhea and corresponding inconveniences, only 19% had visited a specialist for medical advice. It could be concluded that primary dysmenorrhea is a significant issue which impacts day-to-day activities.

Keywords: Primary dysmenorrhea, menstrual, prevalence

Introduction

'Menstruation', refers to the cyclic, shedding of the uterine lining in females of reproductive age.[1] Menstrual cycles are the cyclic and rhythmic physiological changes which occur in females and it often spans for about 28 days.[2, 3] One menstrual cycle is the number of days between the first day of menses (menstrual flow) to the day before the next onset of menses. Menstrual flow or menses averages 4 to 6 days, however the normal range can be 2 to 8 days.[4] Menstrual issues could be in the form of heavy or scanty menstrual flow, irregular cycles or extremely painful menstrual cramps.[3]

'Dysmenorrhea', refers to a severe painful cramping sensation in the lower abdomen, which may radiate to the back and further to the thighs, that occur before and/or during menstrual bleeding or menses.[3,5] Furthermore, the painful sensation is often coupled with a handful of other symptoms, such as nervousness, headache, nausea, increased heart rate, general aching, acne/flushing, slight shivering, sleeplessness, diarrhoea and so on.[5,6] Dysmenorrhea could be differentiated as primary or secondary, where in primary dysmenorrhea the painful sensation occur from contractions in the uterus and are usually more severe during heavy bleeding. On the other hand, secondary dysmenorrhea, refers to menstrual-related pain that accompanies another medical or physical conditions.[3,7]

Most women of reproductive age suffer from primary dysmenorrhea, which may act as an obstacle to achieve or continue one's day-to-day activities. However, the amount of pain is different for each individual. For instance, when the pain is mild, it often does not affect daily activities. Whereas, when the pain is more severe it prevents the completion of

daily routines of some women, which force them to seek for over-the-counter or medical treatments.

Dysmenorrhea is a common menstrual issue in young women of the reproductive age that may disturb the normal routine, hence may lead to incomplete tasks. Most women, regardless of age, suffer from at least one menstrual issue that often results in challenges and risks. Dysmenorrhea is a primary cause which results in activity restriction and absenteeism from school [6,8] or university. [5,9,10,11] Unfortunately, often women have no idea or lack critical knowledge of these conditions or issues.

A. Northern Ethiopia

Primary dysmenorrhea is often the cause of recurrent short-term school, university or work absenteeism in young women of reproductive age. A study conducted in Northern Ethiopia, 2014 shows that the prevalence of dysmenorrhea among health science students was 71.8 percent.[5] In addition, the study concludes that women with a longer duration of menses, long menstrual cycle, positive family history of dysmenorrhea, and who consumes alcohol were more susceptible to dysmenorrhea.[5]

B. Egypt

A study conducted in Assiut City, Egypt (2010-11) shows that the prevalence of dysmenorrhea among adolescents students was 76.1 percent and most reported the duration of their menstrual cramps lasting 48 hours or less.[6] In addition, dysmenorrhea was found to be significantly ($p < 0.05$) associated with older age, earlier menarche, longer cycle length and bleed length, heavy bleeding and irregular cycle. Subsequently, the common symptoms among participants reporting cramps during menstruation were nervousness, fatigue, back pain, headache, irritability, dizziness, and depression[6]. This study had also investigated the impact of dysmenorrhea on academic, sports and social activities and the participants indicated that dysmenorrhea limited their class concentration and participation, sports participation, test-taking skills, homework tasks performance and so on.[6]

C. Sri Lanka

A study had been conducted to assess the knowledge of and attitudes towards dysmenorrhea among adolescent school girls at a school in the Nugegoda Educational Division in the district of Colombo, Sri Lanka. Data collection was done by using non-probability convenience sampling and the results indicated that 84% of the participants had dysmenorrhea. Furthermore, a statistically-significant ($p < 0.05$) association was made between pain and poor mental health status.[12] However, there was no significant association between pain and poor physical health ($p = 0.887$) and poor social health status ($P = 0.395$). [12] In addition, this study states that despite a plethora of studies on dysmenorrhea from around the globe, there was no literature available on dysmenorrhea in Sri Lanka and had further added that Sri Lanka had a reserved cultural background, and open discussions on dysmenorrhea were extremely uncommon; subsequently, some girls were reluctant to discuss such matters, even with their mothers. The study suggested that health-education sessions are important to raise awareness among students of dysmenorrhea.

In primary dysmenorrhea, the painful cramping sensation in the lower abdomen is caused as a result of contractions in the myometrium (middle layer of the uterine wall) inducing local ischemia (an inadequate blood supply to an organ or part of the body), thus providing increased endometrial synthesis of the stimulant prostaglandins.[13] In addition, the pain may last somewhere from 8 hours to sometimes 72 hours.[14] A specific aetiology of primary dysmenorrhea is yet to be determined due to the lack of information. However, it is found out that a combination of several factors, such as, increase in the synthesis and secretion of prostaglandins F_{2a}, increased vasopressin and oxytocin that subsequently enhance the secretion of prostaglandins, and stimulation of the type-C pain fibres.[15,16]

Many females tend to use different remedies to relieve dysmenorrhea such as self-medication and as a result this could lead to further side effects. It is observed that many females tend to consume excess doses of non-steroidal anti-inflammatory drugs (NSAIDs) to relieve the menstruation pain and this could lead to further outcomes such as heart, kidney and liver failures. [14]

Menstrual issues often vary from one individual to another, hence our goal is to give society a proper understanding of this. Furthermore, with the bustling lifestyle of the present society,

women either do not pay much attention to these issues or they are unaware of them. The purpose of this study is to increase awareness of dysmenorrhea before facing any difficulties. Furthermore, there is very limited research on prevalence of primary dysmenorrhea in Sri Lankan undergraduate students.

This research is determined to address the important issues and needs of women with dysmenorrhea to improve their quality of life. The purpose of this study, therefore, is to describe women's salient thoughts about women's experiences of dysmenorrhea. Thereby, the data collected from the this research would be foundational for the assessment of dysmenorrhea and the development of person-centred interventions to support dysmenorrhea management.

The main benefit to the participants in this research is to be able to know the causes of the menstrual issue, the age at which it is most prevalent, the possible treatments and the challenges that this disorder can cause in daily life.

The aim of this research is to determine the prevalence of dysmenorrhea in women and the impact of this for their daily activities. Hence, the findings of this research may assist women to solve multiple challenges or risks faced by them.

Research Methodology

A. Study Design

A cross-sectional study was conducted from July to September 2021, across five selected non-state universities in Colombo District, Sri Lanka. Ethical approval for the research was obtained from Ethics Review Committee, CINEC Campus.

B. Participants

The inclusion criteria for the participants were undergraduate female students in Colombo District, aged 18 to 25 years. Females that experienced no significant pain associated with primary dysmenorrhea and/or were diagnosed with diseases such as pelvic inflammatory diseases, endometriosis and poly-cystic ovarian syndrome will be excluded from the study.

C. Sample Size

According to the obtained information from the 5 non-state universities, the total female student population is 7000 in the 5 universities. Stratified random sampling technique is used to select the participants for the research. The sample size was calculated according to the sample size determination equation published by the division of the National Education Association.[16] Krejcie and Morgan of University of Minnesota, Duluth, have published a reference table with calculated sample sizes for different populations using the above equation.[16] This reference table was used to calculate the sample size for this research. According to the reference table the sample size for the research is 364 undergraduate female students, aged 18- 25 years.

D. Study Instruments

A self-administered, structured questionnaire with questions related to general menstruation (menarche, duration of menses, regularity and duration of menstrual cycle) , dysmenorrhea (painful menstruation) and pain score (mild, moderate and severe) was used as the study instrument in this research to collect the data. In addition, the questionnaire was formulated as a 'Google Form' in English, Sinhala and Tamil.

E. Data Analysis

The obtained data was complied, analysed and evaluated using the IBM SPSS statistics software version 21 to enhance the quality of data.

Results and discussion

Baseline Characteristics

In this survey, out of 364 participants, the average age of the participants was 21.5 years, ranging from 18 to 25 years. Around 37.3% were in the age range of 18 to 21 years and 52.4% were between age ranges of 21 and 25 years. Of the 364 participants, a large proportion (n = 309, 90%) suffered from primary dysmenorrhea, out of which around 42.6% fell within the age ranges of 18 to 21 years, and 57.3% within 22 to 25 years. In terms of ethnic distribution, 96% were Sinhalese, Tamil and Muslim ethnicities each contributed to 1.43% and the rest accounted for other ethnicities.

A. Menstrual Characteristics Associated with Primary Dysmenorrhea

a) Menarche and Menstrual Cycle

The average age of menarche was 12 years, ranging from 10 to 14 years. In terms of the frequency of the menstrual cycles, 89.6% had regular menstrual cycles, whereas, 10.3% had irregular cycles.

b) Length of Menstrual Cycle

A large proportion of the students had menstrual cycle duration of 28 to 35 days (n = 279, 85.6%) which is considered as normal. Since a very small proportion had cycle length of less than 21 days (n = 279, 9.31%) or more than 35 days (n = 279, 5.01%) any associations between cycle length and primary dysmenorrhea was omitted.

c) Menstrual Flow

A significant proportion of participants reported a menstrual flow that lasted around 5-7 days (n = 279, 54.12%) or 2-4 days (n = 279, 43.36%), whereas, only a fraction reported a menstrual flow more than 7 days (n = 279, 2.50%).

d) Intensity of Pain

Around 42.29% (n = 279) of the participants reported mild pain associated with primary dysmenorrhea, whereas, 53.4% reported moderate pain. Furthermore, a small fraction of the participants (n = 279, 4.3%) reported severe pain that disabled one complete one's day-to-day activities

e) Frequency of Pain

Around, 66.6% (n = 279) intermittently experienced pain associated with primary dysmenorrhea, whereas, the rest (33.3%, n =279) of the participants experienced pain and/or discomfort on regular basis.

f) Family History

The Chi-square test showed a significant association between primary dysmenorrhea and family history ($p < 0.001$).

g) Symptoms Associated with Primary Dysmenorrhea

Table 1 denotes the main symptoms associated with primary dysmenorrhea.

Table I - Symptoms Associated with **Primary Dysmenorrhea**

Symptoms	No. of responses	% (n = 279)
Lower abdominal pain	265	94.98
Thigh pain	158	56.63
Back pain	129	46.23
Decreased Concentration	105	37.63
Headache	69	24.73
Loss of appetite	65	23.39
Fever	41	14.69
Nausea, vomiting and diarrhoea	40	14.33
Dizziness	33	11.82

h) Associated discomforts and their affect on the day-to-day activities.

According to the obtained results it was observed that primary dysmenorrhea affected the day-to-day activities of the undergraduate students. The table II denotes the associated discomforts of dysmenorrhea.

Table II - Associated discomforts and their affect on the day-to-day activities.

Variables	No. of responses	% (n = 279)
Trouble falling and/or staying asleep	203	72.75
Poor concentration at class	154	55.19
Limit the ability to move around	133	47.67
Feel depressed/ upset/ sad	88	31.54
Absent from class	70	25.08
Poor personal relationship	42	15.05

i) Methods used to relieve the pain and/or discomfort due to primary dysmenorrhea.

The different methods used to relieve the pain and/or discomfort due to primary dysmenorrhea is depicted in figure 1.

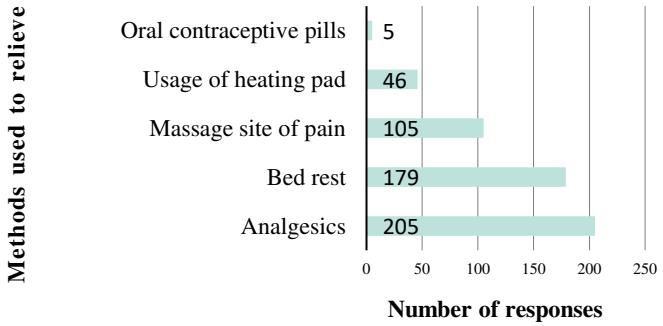

Fig. 1 Methods used to relieve the pain and/or discomfort due to primary dysmenorrhea.

j) Medical Advice

As per the data collected, only a minor fraction of participants who experienced primary dysmenorrhea (n = 279, 18.27%) had received some form of medical advice. However, a significant portion of the participants around 38.7% (n = 279) reported disregarding any of the discomforts associated with primary dysmenorrhea, hence had not received any medical advice. Furthermore, around 73% (n = 279) reported using some form of medication to subside the pain and/or discomfort caused due to primary dysmenorrhea, however, for around 8% the pain still lingered, disabling a smooth flow of daily activities for the participants.

Conclusion

Prevalence of primary dysmenorrhea was 90% (n = 309), out of which around 42% of the students reported mild pain, while 58% reported severe to extremely severe pain. Furthermore, recurrent symptoms associated with primary dysmenorrhea were identified as lower abdominal pain 95%, thigh pain 57% and back pain 46% from all participants. The Chi-square test showed a significant association between primary dysmenorrhea and family history ($p < 0.001$). Moreover, frequency of occurrence of pain was significantly associated with duration of menstrual bleeding (No. of days > 5) ($p < 0.001$). In addition, most of the respondents experienced difficulty in sleeping 73% and difficulty in moving 48%. Consequently, to relieve the pain, many prefer the consumption of analgesics 74%, while, some prefer bed rest 64%. Despite, the significant prevalence of primary dysmenorrhea and corresponding inconveniences, only 19% had visited a specialist for medical advice. It could be concluded that primary dysmenorrhea is a significant issue which impacts day-to-day activities of female undergraduate students in Colombo District, Sri Lanka.

Declaration

A. Study Limitations

This study was restricted to undergraduate female students from non-state universities in Colombo District, Sri Lanka. Therefore, this research could be extended by recruiting participants in other districts and state universities, as well. In addition, the research could be extended by analysing the impact of primary dysmenorrhea on the academic activities of students.

B. Acknowledgement

The authors extend their gratitude to Senior Prof. Menik Hettihewa, Dean, Faculty of Health Sciences, for her guidance and support to conduct this research. Furthermore, the authors also appreciate CINEC Campus, Sri Lanka, for providing an opportunity to expand their knowledge and gain experience in conducting scientific research. Lastly, the participants of this study need to be acknowledged for their valuable information and involvement in the study.

C. Funding sources if any

None

D. Conflicts of Interest

The authors report no conflicts of interest in this work.

E. Ethical Approval

Ethical approval for the was obtained for the research from Ethics Review Committee, CINEC Campus.

F. Informed Consent

All the information used in this study was obtained through participants that had given their consent (the participants that selected the option 'yes' under consent) to participate in the study and/or use their personal information for the study.

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Original Article

Sociological and psychological perspective on spread of COVID 19 Virus: A study on philosophical paradigms

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Abstract

Sociological and psychological perspectives shape and tune the behaviors of individuals. The Philosophical assumptions integrated in these perspectives are highlighted to be key underlying bases to which determine the reality social sciences. Therefore, having a close concentration on Sociological and psychological perspectives on the spread of the COVID-19 Virus through a philosophical standpoint would allow a deeper notion to realize core of the virus spread. However, these philosophical assumptions are underrated within the research fields limiting it to academics. Further, analyzing into this world pandemic is required to realize the entangled outcomes. This paper discusses results of an archival study conducted through a systematic review of literature. A series of ontological and epistemological reveals of social sciences within the sociological and psychological perspectives related to the spread of the COVID-19 virus is stated. A key reveal is that both sociological and psychological research paradigms are balanced within both interpretive and realist studies. However, a tendency towards scoping the research within natural sciences was visible. Which is identified as the requirement of statistical data to justify into socially constructed phenomena howsoever through a technical-rational stance within the society. It was revealed that the citizens feel apathetic on quantified findings as the psychological findings weren't interpreted in simple language. This answered the low number of psychology-based research in comparison to multi-tiered sociological studies. Therefore, the study is concluded encouraging the readers to understand the importance of philosophical paradigms of research in realizing the spread of the COVID-19 virus.

Keywords: Philosophical assumption, Philosophical paradigm, Ontology, Epistemology, and Axiology

Introduction

In 1837 French philosopher Auguste Comte first coined the word sociology. Sociology is the application of a scientific approach when studying the relationship between the society and individual [1]. Sociology is the study of society and consist of human social interactions, rules and regulations, guidelines and processes that connect distinct individuals, not only as a person, but as members of institutes, groups, and organizations. Sociology can be identified as a branch of social sciences and this broad discipline focus on social stratification, social interaction, social relations, culture, and nonconformity. Further sociology as systematic study, approaches sociology which includes both qualitative and quantitative research methods [1]. Furthering the studies of sociology, coincided perspective which is naturally intertwined is the psychological perspective of behavior. According to the American Psychological Association, Psychology is the scientific study of the mind and behavior and it is a multilayered discipline comprising many arenas of studies, namely human development, sports, health, clinical, social behavior and cognitive processes [2]. According to the philosophical point of view, the great philosophers namely Socrates (470 BC – 399 BC) Plato (428/427 BC – 348/347 BC), Aristotle (384 BC - 322 BC) have debated about themes in modern psychology for instance memory, freedom against determinism, nature against nurture, attraction etc. When Psychology evolutes as a discipline, structuralism and functionalism were the two central theoretical perspectives as they discussed in the way which a brain worked. Sigmund Freud (1856-1939) originated psychoanalysis which was a main paradigm in psychology all through the early twentieth century. According to Freud, individuals can be cured by making cognizant their oblivious contemplations and inspirations, consequently gaining understanding [2]. When one attempts to realize the sociological and psychological perspectives on

the spread of COVID-19 virus, it contemplates to identify the nature of the virus in detail.

The COVID-19 pandemic has increased to 331,347 by May 2020 [3] reaching worldwide to over 5 million infected cases. It has now emerged as a public health crisis, and morphed into a global economic crisis, with severe impacts on commercial activity, employment, and trade [4], identified as the world's greatest extinction being described beyond an epidemic. The outspread of the virus is best tested and studied through expert supervision and consultation which is fundamentally explored through its emergent core. When studies are carried on to understanding the spread of the virus in sociological and psychological perspectives based on philosophical standpoints, first revealing is that the societal and mental settings do make it difficult to continue living without ideas due to the main reason where the ideas tend to fold and create a way of life [5].The idealization of underpinning the possibility of revealing analogy between the spread of the virus in parallel to the spread of the philosophical ideas through sociological and psychological perspectives in this process of sense making is important [6]. One may seem to think of the pandemic through the ability to be able to search the reality. With survival, one suffers the pandemic that threatens the. Existence and the very possibility of thinking about it. It is factual to state that all levels of the society do not suffer the spread of the pandemic in the same way. Two main highlights of the available multiple verities of perspectives spread of COVID-19 virus which consistently surface are the sociological and psychological perspectives of the individuals in the broader society. The execution of Socrates because of the threat of his ideas to the power structures of the society and the time which lead to excommunication from his demise [7] explains how similar, the spread of Corona virus and the philosophical underpinnings. Both enters orally and shifts the paradigms for eternal establishments. The fact-based reasoning is that the reality alone imposes ideas on individuals irrespective of the chosen arrangements. Even the simplest or the epidemical virus could mobilize and generate many ideas through philosophy [6] which seamlessly, rationalizes the reason to identifying the spread of Corona virus.

Philosophy if taken in isolation will provoke societies and exert fundamental changes in mentalities so that to mark its affects in history for better or for worse [6]. It can be identified as "search of truth" and derived from the two Greek words referred to as Philos and sopia meaning love and wisdom [8] which guides the believes and values of the thinking of the researchers [9]. Further philosophy can be way of truth or search in knowledge [10]. Research paradigm comprises of ontology, epistemology, human nature, axiology and methodology [9]. Research paradigms are established beliefs and assumptions within a research community about ontological, epistemological, and methodological concerns. Philosophy in social science research will pay a vital role in terms of its ontology, epistemology and methodology. "Ontology concerns the nature of 'reality' where epistemology "is concerned with the nature of knowledge - what forms it takes and how it can be obtained and transmitted [11]. Epistemology on the other hand can be identified as how to know what exists [12]. Furthermore, Epistemology is our belief about how one may come to know the world. During this context of the outbreak of the COVID-19 pandemic, philosophy can be better utilized through researching accurate philosophical assumptions to arrive at the most affective results expected. It aims to give a sense to reality [6]. To derive specific duties, directions, and guidelines to be practiced in the situations available through the rationalization of reflections when catering to available problems, the philosophical paradigms become crucial. Thus, in terms of understanding the spread of Corona virus, which is the crucial most issue in the world it certainly can be thematized with sociological and psychological perceptions which could provide philosophical reflections to reach accuracy in expected results.

Problem Statement

Sociological and psychological perspectives in understanding the philosophical paradigms in spread of Corona 19 Virus is crucial since the andemic has an appalling total effect. Sociological and psychological perspectives discuss the spread of Corona 19 Virus even though philosophical assumptions may be overlooked and often limited to academic purposes. Therefore, it is significant **to** understand how sociological and psychological

perspectives can be addressed through philosophical paradigms and which provide conceptual tools useful to those who make difficult decisions, in communicating and explaining the spread of COVID-19 virus. Research objective is addressed through the use of inductive approach with the collection of data by gathering peer reviewed journal articles. Through the exploration aimed to answer the question, the objective of the study approaches the philosophical paradigms in aforementioned two perspectives. Even though it is the practice to utilized philosophical paradigms only for academic purposes this research attempts to reach and alternative purview.

Research Question

How to identify the sociological and psychological perspectives of spread of COVID-19 Virus through philosophical paradigms?

Research Objective

To explore the sociological and psychological perspectives of spread of COVID- 19 Virus through philosophical paradigms.

Research Methodology

The study is conducted based on archival method using a systematic literature review. The articles selected in the study were chosen subjectively based on a rather socio-political perspective. In order to achieve the objective of the study, 18 articles were selected from a large data base available for review based on sociological and psychological perspectives on the spread of Covid -19 virus. When decided on the articles, consideration has given to peer reviewed research articles from Emerald Insight, SAGE, Elsevier, Science Direct and Springer Link Journals based on their online data bases. Articles were initially selected under the topic of spread of Covid 19 virus specifically relating to sociological and psychological perspectives and philosophical stances only. The search engines were penetrated with the key searches such as "Philosophical paradigms 'AND' COVID-19", "Axiology", "Epistemology", "Ontology 'OR' spread of COVID-19", "Positivism 'AND' spread of COVID-19", "Interpretivism 'AND' spread of COVID-19". The study was conducted using Boolean operators such as "AND", "OR" in par with the two perspectives namely, Sociology and Psychology. The key searches were then streamlined upon the most relevant content to the subjective research area and tabulated in Table 1 given below as the document analysis which was conducted for the study based on each perspective. As a second stage articles were reviewed using the theoretical and empirical information through analyzing the content. Thirdly, collated information interpreted significantly according to the sociological and psychological perspectives.

Perspective	**Article Code**	**Author**	**Name of the article**
Sociological perspective	SA1	(Mehta, 2021) [13]	The Asian region and COVID-19: approaches and gaps in controlling the virus
	SA2	(Sharma, 2020) [14]	Exploration of COVID-19 impact on the dimensions of food safety and security: a perspective of societal issues with relief measures
	SA3	(Noor et al., 2020) [15]	Analysis of public reactions to the novel Coronavirus (COVID-19) outbreak on Twitter
	SA4	(El Maarouf et al., 2020) [26]	COVID – 19: A Critical Ontology of the present

	SA5	(Lourdes Velázquez, 2020) [6]	The role of philosophy in the pandemic era
	SA6	(Raza, 2020) [18]	COVID-19: A Psychosocial Perspective
	SA7	(Aschwanden, et al., 2020) [19]	Psychological and behavioral responses to Coronavirus disease 2019: The role of personality
	SA8	(Perera, Wickramarachchi, Samanmalie, & Hettiarachchi, Psychological experiences of healthcare professionals in Sri Lanka during COVID-19, 2021) [20]	Psychological experiences of healthcare professionals in Sri Lanka during COVID‑19
	SA9	(Webber-Ritchey et al., 2021) [23]	COVID-19: Qualitative Research with Vulnerable Populations
	SA10	(Goldberg, 2021) [16]	Education in a Pandemic: The Disparate Impacts of COVID-19 on America's Students

Psychological perspective	SA11	(Concepción-Zavaleta et al., 2020) [27]	Does level of education influence mortality of SARS-CoV-2 in a developing country?
	SA12	(Rattay et al., 2021) [28]	Differences in risk perception, knowledge and protective behaviour regarding COVID-19 by education level among women and men in Germany. Results from the COVID-19 Snapshot Monitoring (COSMO) study
	PA1	(Sun et al., 2020) [22]	A qualitative study on the psychological experience of caregivers of COVID-19 patients
	PA2	(Sun et al., 2020) [24]	Qualitative study of the psychological experience of COVID-19 patients during hospitalization

	PA3	(Radic et al., 2020) [25]	Fear and Trembling of Cruise Ship Employees: Psychological Effects of the COVID-19 Pandemic
	PA4	(Wang et al., 2020) [17]	Review Article: Psychological Influence of Corona virus Disease 2019 (COVID-19) Pandemic on the General Public, Medical Workers, and Patients with Mental Disorders and its Countermeasures
	PA5	(Saladino et al., 2020) [21]	The Psychological and Social Impact of Covid-19: New Perspectives of Well-Being
	PA6	(Prati & Mancini, 2021) [29]	Review article: The psychological impact of COVID-19 pandemic lockdowns: a review and meta-analysis of longitudinal studies and natural experiments

Source: Authors developed

Table I List of reviewed articles

Results And Discussion

The study discusses several thematic areas identified through an analysis of available contemporary resources on the philosophical assumptions behind the spread of COVID -19 virus. The analysis evolved based on the themes of Sociology and Psychology.

Sociological perspective

The philosopher's task is not to find the meaning of life or to tell others how they should live but to provide conceptual tools useful to those who make difficult decisions, in communicating and explaining them to others [6]. Within the audit, there were five coordinate articles alluded to which were basically taking a relativist and interpretivist ontological assumption affirming the natural stance to which social sciences are philosophically evaluated with a heading of interpretivism which affirms that there can be multiple realities behind the spread of corona virus. The articles primarily have taken after the technique of archival research investigating shortlisted articles based on key words such as COVID-19, coronavirus, severe intense respiratory syndrome-like coronavirus (SARS-CoV-2), widespread, infection, isolate, etc. [13]. Examining the different roles of government, technology, business–government collaborations and topographical and demographical structures within the society. The studies support the sociological assumptions behind the spread of COVID-19 infection advocating a social constructivist epistemology.

Larger part of these inductive studies show work which are induced on the spread of COVID-19 virus, consequently, outlays the theoretical viewpoints of as it were the causes behind the spread. But these viewpoints depict the continuous scenario's impacts, expanding its suggestion to the

individuals coming from the industry and the scholarly world background. There were assist investigate, which endeavored considering these sociological contexts on an objective based philosophical assumption with a realistic ontology. The subjective ontologist made decisions to imposed lockdown and curfew halted the various modes of transportation causing disruption in the food supply chain due to which commodities could not be delivered to the customer [14]. A highlight was an investigation of COVID-19 tweets conducted through VOS viewer looking at the responses of the individuals related to the COVID outbreak within the world examining the subjective opinions of the common open through a deterministic epistemology [15].

Highlighted inside the sociological viewpoint, a few instructive considers were essentially unmistakable on its philosophical presumptions. In this way, considered to be portrayed inside the study as a separate viewpoint. Among the inductive methodological headings, educational and literacy levels as major reasoning behind the spread of COVID-19 widespread has been investigated. The stress caused by the widespread on lesbian, cheerful, androgynous, transgender and strange (LGBTQ+) understudies in rudimentary and auxiliary schools of USA have confronted especially increased dangers for uneasiness and stretch and have misplaced normal get to confirming understudy organizations and steady peers, instructors, and school staff were moreover considered (Office of Instruction Office for Respectful Rights, 2021). In this paper, authors have discussed educational aspect under the sociological perspective as educational sociology is the branch of behavioral science which deals with social aspects of education [1]. Therefore, sociological approach to education impact on COVID 19 virus discussed under the sociological perspective.

Positivistic examinations have affirmed that the ethnic and socioeconomic positions affecting the level of instruction expanded the spread of COVID-19 widespread. The experimental epistemologies generalize the hardship and low educational fulfillment were reliably related with a tall hazard of affirmed diseases [16). Further, studies uncovered that more grounded affiliations were apparent with the level of instruction and the spread of COVID-19 infection. These experimental, survey-based studies always legitimize the philosophical base and exactness in generalizing the discoveries such as highly educated male was profoundly dreadful of the widespread while less educated male respondents were more inclined to cause the spread of the infection [16].

Psychological perspective

Psychology ordinarily considers the root cause of human behaviour [17]. Hence, the analysts tend to generalize the discoveries through positivist analysts, be that as it may, in reaction to Covid and in terms of deciding the spread of COVID – 19 infections, the accessible assets were obvious from both inductive and deductive strategies. This gives evidence for a more adjusted and steady philosophical assumption spread over the research world inside the psychological viewpoints.

The psychological analyst in this way appears to be clearly distinguishing the spread of COVID-19 infection inside the viewpoint. Conceptual tools in deciding the relationship of religious beliefs, family [33] and parental education [18], social protections, mental wellbeing, life fulfillment, identity characteristics, mental and behavioral reactions [19], Epidemiologic, psychosocial and word related variables predictive of depression and anxiety [20] were considered employing a realistic ontology with an empirical epistemology while psychological well-being of the foremost exposed groups, counting children [34] , college understudies, and wellbeing laborers, who are more likely to create post-traumatic push clutter, uneasiness, sadness, and other side effects of trouble [21] due to the COVID – 19 widespread were too considered utilizing positivist epistemological assumptions.

On the other hand, phenomenological ponders examining psychological perspectives of the spread of COVID-19 infection such as negative feelings, fatigue, inconvenience, weakness was caused by high-intensity work, fear and uneasiness [22], warmth and gratefulness, improvement of proficient duty, and self-reflection moreover showing positive feelings happened at the same time with negative feelings were too tested. Further, the significance of Subjective research methodology in bringing consideration to the lived

experience of others as they unfold [23] are tried comprehensively giving a more extensive scope of in depth understanding on the viewpoint in different think about groups and respondents such as psychological practices of COVID-19 caregivers [22] and COVID patients [24].

Sequential studies on in-depth investigation Firstly, testing attitudes such as fear, refusal, and disgrace, Besides, the major source of push on viral nature of the illness, isolate measures, and concerns with respect to the wellbeing of family individuals [31] , Secondly, responses of body and intellect specifically enthusiastic reactions, intemperate consideration to indications, rumination, and changes in count calories, rest, and behaviour [32] , Thirdly, the variables included mental alterations, therapeutic care, family and social background. Further long-lasting illnesses brought about in mental development and patients viewed issues with appreciation through cherishing of life, family, bravery, and relentlessness [25]. Radic et al., 2020 were unmistakably social examined with relativist ontologies and interpretivist epistemological assumptions.

Conclusion

The study conducted reviews key available research within the sociological and psychological perspectives of the spread of COVID-19 pandemic. Through the highlights of how philosophical standpoints shape and tune the behavior of individuals as well as the society as a whole, the study is led to encourage the reader to realize the importance of philosophical paradigms in understanding the spread of the COVID-19 pandemic. Correspondingly evidence denotes that there is a role of philosophy in pandemic era [6]. The work presented is carried out by deeper evaluation of archived journal articles published on the concurrent spread of the virus worldwide. Authors have attempted to cover the key reports grounded on critical analyses and have approached to review the articles. This has led to identify the roots of philosophical assumptions on the spread of the COVID-19 pandemic. Comparative critical discussions on the parallel and past pandemic outbreaks around the world and their implications in sociological and psychological perspectives were based when structuring the study. Continuation of reviews saturated that both sociological and psychological research paradigms are equally used within interpretive as well as realist studies [30]. Whereas a deeper reveal was that there is a tendency towards extending the research to natural sciences. This was identified as a social need for statistical justification based on purely technical-rational viewpoints to absorb socially constructed phenomena. Understanding core sociological and psychological perspectives on the spread of the virus, authors have suggested few remedial actions helping and streamlining the controls, future avenues, loss recovery mechanisms, revival of industries and operations due to the spread of COVID-19 virus. The study can therefore by concluded by identifying the sociological and psychological perspectives of spread of COVID- 19 Virus through philosophical paradigms longing to new normal.

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Original Article

Use of Concrete Waste from Industries as an Alternative Material for the Permeable Concrete Production

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Abstract

Every year, tons of demolished concrete waste items dump into the environment from the construction industry. With this process, a massive environmental pollution occurs. Therefore, in this research, the main aim is to find a solution for this environmental pollution by recycling this waste products. The main objective is to recycle these concrete waste materials from industries to use as an alternative material for the production of permeable concrete by maintaining the recommended compressive strength and the recommended permeability. Permeable concrete can be used for the concreting of floor areas like car parks. It provides environmentally friendly way to drain storm water without flooding. For this research, cement to aggregate ratio was used 1:5 and 14mm to 20mm size natural coarse aggregate and concrete waste were used. The control sample was prepared using 100% aggregate. With total amount of aggregate weight 5%, 10%, 20%, 30%, 40% amounts were replaced with the waste concrete after preparing 14mm to 20mm size samples. The slump test, compressive strength test and the permeability tests were conducted. According the results of the 28 days compressive strength test, the control sample was obtained 7.423MPa strength but neither of any other sample could not reached this strength. However, the sample which replaced with the 10% of waste concrete with 90% natural coarse aggregate has obtained 88.683% strength compared to the control sample. According to the permeability results it shows that there will not have a great impact by using concrete waste as an alternative material in permeable concrete production. The results were varied between 15.8L/m^2/s to 15.08L/m^2/s.

Keywords: Permeable concrete, Compressive strength, Permeability, Recycling

Introduction

Concrete comes in a variety of forms, some of them can be utilized for the same purpose. It depends on the purpose which wants to achieve. Permeable concrete is a different type of a concrete mix. This permeable concrete is a high-porosity concrete that allows water and air to pass through it and is used for flatwork applications. The permeable concrete mix mainly consists of cement, coarse aggregate, and water. Fine aggregates are rarely used in permeable concrete (Obla, 2010). The compressive strength and permeability of the permeable concrete mainly depend on the coarse aggregate size (Obla, 2010). Permeable concrete mainly uses in the construction field for parking areas, pedestrian walkways, and for greenhouses.

With the incensement of the construction activity, it causes to the incensement of the generation of construction waste. The traditional method of disposal of the construction waste is by disposed into a land. In a country like Sri Lanka, the land space to dump waste will not be enough in the future. This construction waste disposal causes to a massive environmental pollution. Many countries have already performed researches on this issue and many countries have already applied the solutions in practically to reduce this construction waste generation. However, in Sri Lanka, this method is not yet usually encountered.

There are many advantages in the use of permeable concrete. The permeable concert is a good solution for stormwater management. By using permeable concrete near tree areas, it allows water and air to go to the roots of the trees, and also there are many economic benefits also (Obla, 2010).

In permeable concrete production, coarse aggregate is a main element but when consider

about the source depletion of natural resources, must move to use alternative materials.

In order to reduce the environmental pollution, either these construction wastes can be recycled or reused. Advantages by recycling of construction waste can be identified as to reduce the environmental pollution, solution for the resource shortage and permeable concrete becomes economical. Aim of this research has been identified to reduce the generation of concrete waste by producing permeable concrete using demolished concrete waste as an alternative material by replacing 14mm to 20mm coarse aggregate and maintaining the required strength for the permeable concrete.

Methodology

As the first step, the sieve analysis test was conducted for coarse aggregates to determine the particle distribution. Then the single range size natural coarse aggregates and the waste concrete parts were separated using the mechanical sieve shaker. Then the methodology was divided into two investigations. The first stage is to determine the best mix ratio to produce the control sample while achieving the height compressive strength. Therefore, by referring the previous research papers different mix ratios were chosen and from those eighteen cubes were casted for eighteen different mix ratios (Table 1). Seven days compressive strength test was conducted for these eighteen cubes and from the results, the mix ratio which obtained the highest compressive strength was selected for the second stage.

In the second stage, natural coarse aggregates were replaced with concrete wastes in six different ratios (0%, 5%, 10%, 20%, 30%, and 40%) with respect to the selected control sample (Table II). The slump test was conducted for each mix. And, four cubes were casted from each mix for seven days, fourteen days, twenty-eight days for compressive strength tests, and for the permeability test.

A. Mix Proportion

Sample no	Cement :Aggregate (V/V)	Water: Cement (V/V)	Cement	Coarse Aggregate (C/A)	Water
1	1:5	0.25	0.81	6.75	0.205
2	1:5	0.28	0.81	6.75	0.227
3	1:5	0.3	0.81	6.75	0.243
4	1:5	0.32	0.81	6.75	0.259
5	1:5	0.35	0.81	6.75	0.284
6	1:5	0.5	0.81	6.75	0.405
7	1:6	0.25	0.694	6.943	0.174
8	1:6	0.28	0.694	6.943	0.194
9	1:6	0.3	0.694	6.943	0.208
10	1:6	0.32	0.694	6.943	0.222
11	1:6	0.35	0.694	6.943	0.243
12	1:6	0.5	0.694	6.943	0.347
13	1:7	0.25	0.608	7.088	0.152
14	1:7	0.28	0.608	7.088	0.17
15	1:7	0.3	0.608	7.088	0.182
16	1:7	0.32	0.608	7.088	0.194
17	1:7	0.35	0.608	7.088	0.213
18	1:7	0.5	0.608	7.088	0.304

Table I: Material Quantity for 1-18 Sample (Material Weight for 150 *150*150 Sixe one cube)

Sample no	C/A %	Waste concrete %	Water :cement	Cement (kg)	C/A (kg)	Waste concrete (kg)	Water (kg)
19	100	0	0.5	0.81	6.75	0.000	0.41
20	95	5	0.5	0.81	6.41	0.334	0.41
1	90	10	0.5	0.81	6.07	0.675	0.41
22	80	20	0.5	0.81	5.40	1.350	0.41
23	70	30	0.5	0.81	4.72	2.025	0.41
24	60	40	0.5	0.81	4.05	2.700	0.41

Table II: Material Quantity fro 19-24 Sample (Material Weight for 150 *150*150 Sixe one cube) Selected control sample is 1:5 (Cement: Course Aggregate)

B. Permeability Test

To determine the permeability, the following model was made by the candidate.

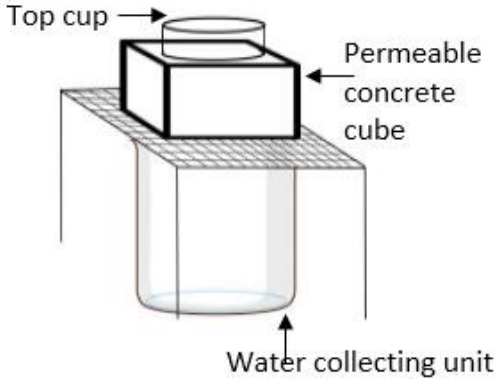

Fig. 1: Model to determine the permeability

Water was poured into the top cup and the stopwatch was started as immediately the water pouring starts. After 2L of water was collected to the water collecting unit the stopwatch stopped and the counted time was written down.

Results and Discussion

A. Sieve Analysis Test

This test was done according to the BS 812-103.1:1985. 50, 37.5, 20, 14, 10, 5, 2.36mm size sieves were used. According to the graph (Figure 1), majority of particles were distributed in between 10mm to 20mm. The results were shown in Table III.

Size (mm)	Mass retained (kg)	Cumulative retained (kg)	Mass passing (kg)	% Passing
50	0	0	1.001	100
37.5	0	0	1.001	100
20	0.058	0.058	0.943	94.21
14	0.545	0.603	0.398	33.76
10	0.356	0.956	0.042	4.2
5	0.037	0.996	0.005	0.5
2.36	0	0.996	0.005	0.5
pan	0.002	0.998	0.003	0.3

Table III : Sieve Analysis Results

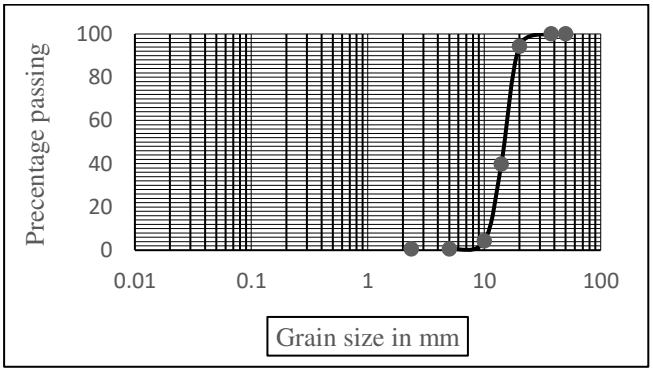

Fig 1: The particle size distribution graph for coarse aggregates

B. Workability

The slump test was conducted to sample 19, 20,21,22,23 and 24. The results of the slump test shown in Figure 2.

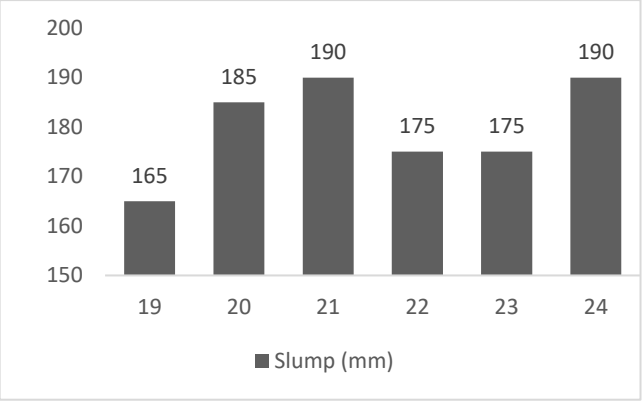

Fig. 2: Slump test results

According to results, the lowest slump value was obtained by the 19 – sample which was made only using natural coarse aggregates. All other five samples which were made with natural coarse aggregates and waste concrete. These test samples obtained the slump value between 175mm to 190mm. These tests were done on a typical windy day. Therefore, slump test results could be affected by the evaporation factor. Also, the slump is dependent on the factors like properties of concrete ingredients. With these results can conclude that the workability of the permeable concrete depends on aggregate types and properties.

C. Compressive Strength

Determine the best mix ratio:
To determine the best mix ratios eighteen samples were casted. The mix properties and the results of the eighteen samples were shown in table IV. These results were obtained by seven-day compressive strength test.

Sample no	Concrete: C/A	Water binder ratio	7days compressive strength (MPa)
1	1:5	0.25	Failed
2	1:5	0.28	0.399
3	1:5	0.3	0.708
4	1:5	0.32	2.966
5	1:5	0.35	5.565
6	1:5	0.5	6.663
7	1:6	0.25	Failed
8	1:6	0.28	0.025
9	1:6	0.3	1.046
10	1:6	0.32	2.504
11	1:6	0.35	2.263
12	1:6		2.42
13	1:7	0.25	Failed
14	1:7	0.28	1.334
15	1:7	0.3	1.451
16	1:7	0.32	1.276
17	1:7	0.35	1.36
18	1:7	0.5	2.469

Table IV: Compressive Strength Results (Sample no 1-18)

According to a previous research, the 28-Days compressive strength typically varies between 2.758MPa to 27.58MPa (Mohammed et al, 2017). Only sample numbers 4, 5, and 6 of this experiment were achieved more than 2.758MPa strength for seven days compressive strength. The height result obtained from the 7-Days compressive strength was 6.663MPa and it was achieved by sample no – 6. Therefore, for the further experiment, this mix ratio was selected to use.

Furthermore, from these results, it can be observed that the compressive strength was varying based on the water-cement ratio. The sample no 1, 7 and 13 were failed due to weak bonds between cement and coarse aggregate as a result of inadequate water amount.

Permeable Concrete Mix with Waste Concrete:
The mix properties were shown in table V and the seven days, fourteen days and twenty-eight days compressive strength test results were shown in Figure 2 with the replaced amount of waste concrete percentages.

Sample no	C/A %	Waste concrete %	Cement: C/A	Water binder ratio
19	100	0	1:5	0.5
20	95	5		
21	90	10		
22	80	20		
23	70	30		
24	60	40		

Table V: Mix Properties

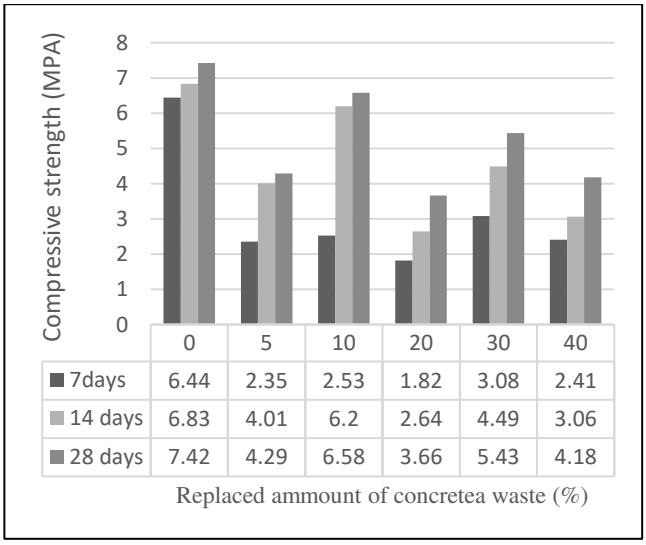

Fig. 2: Compressive strength result (Sample no 19 - 24)

According to the ACI 522 – 06, the minimum compressive strength of the permeable concrete is 2.758MPa and the control sample (sample no – 19) has achieved that value in seven days. However, the highest compressive strength was obtained by the control sample after twenty-eight days of the test. The fourteen days compressive strength of permeable concrete which made with natural coarse aggregate and concrete waste ranging from 2.638MPa to 6.095MPa. The highest compressive strength of these samples was obtained by replacing 10% of concrete waste with natural coarse aggregate. There is a clear difference in the compressive strength between the control sample (sample no – 19) and the other samples which consist of both natural coarse aggregate and concrete waste. The control sample (sample no 19) was obtained a strength of 7.423MPa in twenty-eight days. This was the highest compressive strength value which obtained from all six samples in twenty-eight days. All the other samples which consist of both natural coarse aggregates and waste concrete particles have obtained a value between 3.658MPa to 6.583MPa. For the decrease of the compressive strength, the aggregate size could not be affected because a single size range (14mm to 20mm) of natural coarse aggregate and concrete waste were used in the mixture. Therefore, it can be determined that the compressive strength was decreasing compared to the control sample due to the properties of the concrete waste because in used concrete waste there were aggregate particles and also grout particles. These grout particles could be the major reason to decrease the strength of the samples because it has a lesser strength.

E. Permeability

Figure 3 shows the results of the permeability. The test was performed with a constant water pressure and with a constant falling height. 2L amount of water used for each stage and the top cup area was 6.362×10^{-3} $m^{2.}$ The test was performed three times for each sample and the average time was taken to calculate the permeability rate (k).

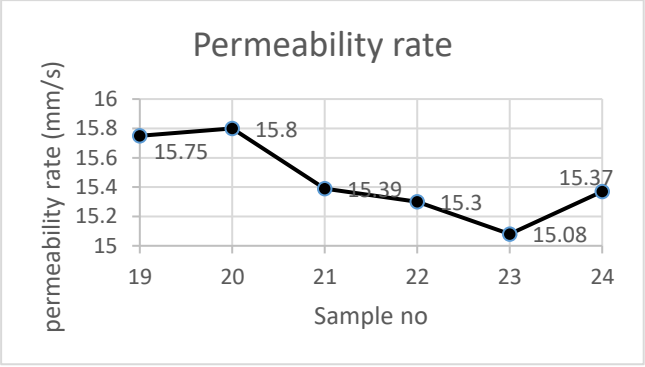

Fig. 3: Permeability rate

The highest permeability rate of 15.8mm/s was obtained by sample no 20. With respect to the sample 19 and 20, there is a decrement of the permeability rate in other four samples but all the samples varied between 15mm/s to 15.9mm/s. According to the results, it can be concluded that either there was variation in the permeability rate of each sample, by using concrete waste as an alternative material in permeable concrete production in the above replacement percentages, it does not affect to the permeability rate because the variation of the above results might occur due to the human error and a significant difference was not observed.

Conclusion

For this study, 14mm to 20mm size natural coarse aggregates and concrete waste aggregates were used with 1:5 cement, coarse aggregate ratio, and with 0.5 water binder ratio. The replacement was done with six different percentages.

According to the obtained results from the slump test can conclude that by using waste concrete particles to the permeable concrete mix can improve the workability of the mix. In this experiment, the control sample was obtained 165mm of slump value but all other samples which consist of both natural coarse aggregates and waste concrete particles have obtained a slum result of more than 165mm. The highest slump value result obtained from this study was 190mm and it was obtained by replacing 10% and 40% of concrete waste with natural coarse aggregate.

The twenty-eight days compressive strength of the control sample was 7.423MPa but neither of any other samples could not achieve this strength in twenty-eight days. According to the ACI 522-06 standards, the compressive strength of the permeable concrete is varying between 2.758MPa 28MPa. However, in this research, every sample have achieved a strength beyond the minimum value of the ACI 522-06 standards. The samples which made by replacing the natural coarse aggregates with the concrete waste were obtained a compressive strength between 3.658MPa to 6.583MPa in twenty-eight days. From those samples sample-no 21 which consists of 90% of natural coarse aggregates and 10% of concrete waste was obtained the highest compressive strength (6.53MPa) after the control sample and it was 88.683% of strength achievement with respect to the control sample.

The obtained results of the permeability rate were varied between 15.8L/m^2/s to 15.08L/m^2/s. the obtained results were vary between a small ranges. Because of that it can be concluded by using concrete waste as an alternative material with the above percentage amounts it will not affect to the permeability rate much. The control sample has achieved 15.75L/m^2/s of permeability rate. 15.8L/m^2/s is the highest permeability rate that could be achieved from this study. It was achieved by using 5% of concrete waste by replacing natural coarse aggregates. The sample no 21 has obtained 15.39L/m^2/s permeability rate.

This study shows that by replacing concrete waste with natural coarse aggregates to produce permeable concrete it will affect to the compressive strength negatively but according to the workability and the permeability, the use of concrete waste for the permeable concrete mix is suitable. However, according to this study, 10% of concrete waste is the most appropriate amount to replace the natural coarse aggregate for permeable concrete production because according to the results of this research it was obtained 88.683% of strength with relevant to the control sample, 190mm of slump and 15.39L/m^2/s of permeability rate.

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