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Message from the Vice Chancellor

It is with great pride and admiration that I extend my warm congratulations to the Faculty of Allied Health Sciences, University of Ruhuna, on the momentous launch of The Sri Lankan Journal of Allied Health Sciences (SLJAHS). This journal will serve a broad and diversified community of researchers, clinicians, academics, and policymakers across a wide range of allied health disciplines including Nursing, Medical Laboratory Science, Radiography, Pharmacy, and Physiotherapy.

By offering a dedicated and reputable platform for sharing high-quality scientific findings, this initiative will significantly contribute to the growth of evidence-based practices in healthcare while encouraging academic collaboration both locally and globally. The journal's open-access policy will ensure that cutting-edge research is widely available, promoting knowledge sharing, innovation, and application in real-world healthcare delivery.

As the Vice Chancellor of the University of Ruhuna, I wholeheartedly commend the Faculty of Allied Health Sciences for this visionary undertaking. I am confident that SLJAHS will rapidly emerge as an example of academic excellence in the region and beyond.

I wish continued success with the Editorial Board, contributors, and all those involved in this scholarly endeavour.

Senior Professor PA Jayantha
Vice Chancellor

Message from the Dean

It is both an honour and a privilege for me to write this message for the inaugural issue of the *Sri Lankan Journal of Allied Health Sciences*, proudly published by the Faculty of Allied Health Sciences, University of Ruhuna (UoR).

The Allied Health Sciences (AHS) degree programs at UoR began within the Faculty of Medicine on 20th October 2008, welcoming the inaugural batch of 19 Medical Laboratory Science and 37 Nursing undergraduates. Since then, the Faculty of Allied Health Sciences (FAHS) was formally established in September 2017 as the 10th faculty of the University of Ruhuna. This significant development aimed to expand higher education opportunities in allied health sciences and enhance the quality of training for the nation's healthcare workforce.

The faculty's mission is to prepare competent, compassionate, and reflective allied health professionals who excel in patient care, collaborate effectively with other healthcare professionals, and grow into future leaders, educators, and researchers in health sciences.

To meet the increasing demand for space and student welfare, the faculty constructed a new, state-of-the-art building in Walahanduwa, Galle, where academic activities commenced in March 2025. Currently, the Faculty comprises three departments: Nursing, Medical Laboratory Science, and Pharmacy. Plans are underway to introduce new undergraduate programs in Public Health Sciences, ECG Technology, and EEG Technology. Additionally, the Departments of Nursing and Medical Laboratory Science have initiated efforts to establish postgraduate degree programs.

FAHS is privileged to have a dynamic, young academic staff equipped with local and international postgraduate qualifications, dedicated to supervising undergraduate research with strong support from experts across extended faculties. Our academic team has contributed extensively to national and international scientific literature, presenting hundreds of manuscripts, conference abstracts, and authoring

several textbooks across disciplines. Faculty members have also secured three patents, multiple local and international research grants, and prestigious research and lifetime achievement awards.

Since its inception, the faculty has actively promoted research by organizing an annual research symposium —RuFARS— which has evolved over time into an internationally recognized event. This month, we are proud to host the 3rd International Research Symposium of the Faculty.

The establishment of the *Sri Lankan Journal of Allied Health Sciences* represents a major milestone for the faculty. A dedicated peer-reviewed journal provides a vital platform for our academic community to disseminate new knowledge, share innovative research findings, and engage in scholarly discourse. It strengthens the faculty's research culture and elevates its academic profile nationally and internationally.

Having a faculty journal also encourages faculty members and students to actively participate in research, enhancing their skills in scientific writing, critical thinking, and evidence-based practice. It fosters interdisciplinary collaboration by bringing together diverse perspectives within allied health sciences and related fields.

Moreover, the journal will serve as an important resource for healthcare practitioners, policymakers, and educators by providing timely access to relevant research that can inform clinical practice, health policies, and educational curricula. This aligns perfectly with our faculty's commitment to contribute meaningfully to the advancement of healthcare in Sri Lanka and beyond.

I extend my heartfelt gratitude to Editor-in-Chief Professor WVRTDG Bandara, the entire editorial board, colleagues who contributed to this publication, and to all researchers who submitted their valuable work for this inaugural issue. Your dedication and hard work have made this important achievement possible.

Together, we look forward to the continued growth and success of the *Sri Lankan Journal of Allied Health Sciences* as a beacon of excellence, innovation, and impact in allied health research and education.

Professor Imendra Kotapola
Dean
Faculty of Allied Health Sciences
University of Ruhuna

Message from the Editor-in-Chief

It is my great privilege and pleasure to present this inaugural issue of the Sri Lankan Journal of Allied Health Sciences (SLJAHS); the official publication of the Faculty of Allied Health Sciences, University of Ruhuna, Sri Lanka. SLJAHS aims to offer a reputed scientific forum to disseminate high quality research findings in all areas in health sciences, facilitating the integration of research findings into clinical practice, healthcare delivery and policy-making. This newborn, open-access, peer-reviewed, bi-annual, e-journal strives to make a significant influence upon the field of health sciences publishing impactful research findings and expensive opinions in the form of original research articles, systematic reviews and meta-analysis, brief reports, case series/reports, clinical audits, study protocols, commentaries and editorials/letter to editor. Our ambitious goal is to serve the researchers, practitioners and experts with a robust platform to share their work, contribute to the advancement of health science, and engage in dialogue with their peers.

On behalf of the Editorial Board, I would like to extend a very warm welcome to the readership of SLJAHS. We wish to encourage incessant contributions from the national and international scientific community to ensure a sustained success and advancement of the journal. We also welcome comments and suggestions that could improve the quality of this newborn journal.

I take this opportunity to thank Senior Professor P.A. Jayantha, Vice Chancellor, University of Ruhuna and Professor Imendra Kotapola, Dean, Faculty of Allied Health Sciences for their valuable guidance and support. I further thank all heads of the departments, academic staff, Ms. Pavithra Mayuri, Senior Assistant Librarian, Mr. Harshana Prasad, Net Work Manager, FAHS and all faculty members for their kind assistant throughout. I am grateful to all authors and reviewers immensely, all of whom have volunteered to contribute to the success of this first issue of journal. The great commitment by the members of Editorial Board and the hard work by Ms. P.M. Nanayakkara, Editorial Assistant is highly appreciated and launching this journal would not have been possible without their support. I am grateful to Dr. Aruna Dissanayaka for his support on language editing and to Mr. Ashan Somasiri for designing the cover page. This scholarly initiative was taken by the faculty parallel to the 3rd International Research Symposium of the Faculty of

Allied Health Science (iRuFARS-2025). The continuous support and encouragement by Dr. KB Gunawardana, Chairperson, iRuFARS-2025 is highly admired.

I consider it an honor to be the first Editor-in-Chief of the Sri Lankan Journal of Allied Health Sciences and, with my dedicated and motivated team look forward to making SLJAHS a prestigious and well-regarded journal in the field of health sciences. Finally, we invite all readers and fellow researchers to submit manuscripts to this journal.

Professor WVRTDG Bandara
Editor-in-Chief

Message from the Chairperson iRuFARS 2025

It is with profound pleasure that I convey this message in the inaugural issue of 'The Sri Lankan Journal of Allied Health Sciences' as the chairperson of iRuFARS 2025. The launching of this scientific journal in parallel to the 3rd International Research Symposium of the Faculty of Allied Health Sciences, University of Ruhuna makes the event historically and scientifically significant.

As academics, one of our key priorities is to disseminate research findings. I consider the launching of this journal as a result of such an effort. Research findings can be disseminated in many ways, such as abstract presentations at various symposiums, proceedings such as iRuFARS, however, publishing findings in a reputable, peer-reviewed journal gives much more credibility and value to research work. Therefore, the launching of 'The SLJAHS' will open up new avenues to discuss challenges, developments and novel discoveries in healthcare in a more vibrant space.

I congratulate and extend my sincere gratitude to the Editor-in-chief, Prof. WVRTDG Bandara, and the editorial board for this scholarly effort to bring 'The Sri Lankan Journal of Allied Health Sciences' to life. Establishing a new journal requires great commitment and enthusiasm. Your extreme dedication and perseverance to achieve this task is commendable. I also take this opportunity to thank the authors, editors and reviewers, all of whom have volunteered to contribute to the success of the journal.

As a faculty, we humbly rejoice this scientific victory, and deep inside, we feel the urge to continue this effort to reach higher goals and standards. I sincerely wish that 'The Sri Lankan Journal of Allied Health Sciences' thrives to be among the mostly read healthcare journals in Sri Lanka.

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Original Research

Blood Culture Positivity Rates among Babies Admitted to the Premature Baby Unit of a Secondary Care Hospital in Southern Sri Lanka: An Analysis of Microbial Isolates and Antimicrobial Susceptibility Patterns

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Abstract

Bloodstream infections are a major cause of morbidity and mortality among babies in premature baby units (PBU). Periodic monitoring of the antimicrobial sensitivity of the causative organisms in a particular setting is important for the early management of infections in babies. The aim of this study was to determine the proportion of blood culture positivity and to assess the factors associated with bloodstream infections among the babies and the causative microorganisms and their antibiotic susceptibility pattern, isolated in blood cultures of babies with suspected sepsis admitted to PBU at District General Hospital Matara (DGHM). An institution based cross-sectional study was conducted in microbiology laboratory of DGHM to review blood culture reports received from PBU retrospectively. All the consecutive samples from the PBU from January 2021 to December 2022 were included in the study. Data on culture isolates, antibiotic susceptibility patterns and related variables were collected and analysed using SPSS version 25.0. Over the study period, 1612 blood cultures had been sent to the laboratory from the PBU. Overall blood culture positivity rate was 9%. The majority of isolates were gram-positive organisms (68%). Coagulase-negative staphylococci (51.6%) were the most common isolates, followed by lactose fermenting coliforms (16%) and *Pseudomonas spp.* (8%). Amikacin showed a higher sensitivity than gentamicin among gram-negative organisms. Carbapenem resistance was observed in 40.5% of the isolates. Among *Staphylococcus aureus* 55.6% were methicillin-resistant and 44.4% were methicillin-sensitive. Prematurity (p=0.017) and low birth weight (p=0.002) were significantly associated with culture positive sepsis. Preterm and low birth weight were significantly associated with bloodstream infections among babies admitted to PBU of DGHM. Coagulase-negative Staphylococci, lactose fermenting coliforms, and *Pseudomonas spp.* were the predominant causative organisms.

Keywords: *Antibiotic susceptibility pattern, Blood culture, Neonatal bloodstream infections, Premature babies*

Introduction

Bloodstream infections are invasive bacterial infections that spread into blood stream and bacteremia refers to presence of viable bacteria in blood [1]. Early-life infections are a common contributor to health complications and neonatal sepsis remains a significant cause of morbidity and mortality among newborns, especially in premature and low birth weight infants [2]. A baby born before the 37th week of gestation is known as a premature baby or a preterm baby. One in ten newborns is born before completion of 37th week [3]. Sepsis occurs within first 72 hours of birth is categorised as early onset sepsis (EOS) and sepsis occurs after first 72 hours is categorised as late onset sepsis (LOS) [4].

Immunological status determines the clinical progress of the disease. Immune function in premature babies is a major contributor to the risk of infections [3]. Infections in PBU are highly infectious and it results in a high mortality rate and serious complications as premature babies do not have well-developed immune system.

Blood stream infections are a common problem of neonates in premature baby units (PBU). Blood culture remains the gold standard for diagnosing bloodstream infections, and early detection through culture-based methods, is essential for guiding effective antimicrobial therapy. PBU provides specialized care to neonates who are vulnerable to a range of infections due to their underdeveloped immune systems, prolonged hospital stays and frequent invasive procedures. Understanding the prevalence of positive blood cultures, organisms causing infections and antibiotic susceptibility pattern among neonates admitted to the PBU is critical for improving infection control measures. Also it is beneficial in avoiding unnecessary usage and optimising empirical antibiotic treatment [5]. Changing pattern and frequent development of resistant bacteria is another problem arising during the management of these neonates. Antimicrobial sensitivity pattern differs in different studies as well as at different times in the same hospital [6,7] Therefore, periodic monitoring of the antimicrobial sensitivity of the causative organisms in a particular setting is important for the early management of infections in babies.

Neonatal sepsis is a complex clinical condition influenced by a variety of maternal, perinatal, and neonatal factors [8,9]. Understanding these associated factors is crucial for early identification of at-risk neonates and the implementation of targeted preventive and management measures.

DGHM is a major tertiary care institution in the Southern Province of Sri Lanka, receiving a substantial number of neonatal blood samples from its PBU for microbiological testing. Therefore, this would be a preliminary study that can support the improvement of infection control measures and the management of babies with bloodstream infections in PBU. The study aims to determine the proportion of blood culture positivity among neonates admitted to the PBU at DGHM. Also to identify the risk factors and the common causative microorganisms and their antibiotic susceptibility patterns, isolated in blood cultures of neonates with suspected sepsis admitted to PBU at DGHM.

Methods

Study design and setting

An institution based, cross-sectional study was conducted in microbiology laboratory of DGHM to review blood culture reports of neonates received from PBU retrospectively.

Study population

The sample size was calculated using the formula for estimating prevalence in cross-sectional studies, as described by Lwanga and Lemeshow (1991) in sample size determination in health studies. The minimum sample size required was 384. All the consecutive samples from the PBU from January 2021 to December 2022 were taken into study. Reports of all the blood cultures received to laboratory from PBU were included and reports of repeated positive blood cultures from the same neonate which grew the same organism were excluded from the study.

Processing of blood cultures

Blood cultures had been processed using automated blood culture and manual methods according to the Standard Operating Procedures for blood culture in the Laboratory Manual in Microbiology by the Sri Lanka College of Microbiologists. Antibiotic sensitivity testing had been performed by clinical laboratory standards institute disc diffusion method.

Statistical analysis

Positive and negative culture results and other related details like Socio-demographic details of neonates were obtained through review of the request forms. Data were entered into excel sheets and analysed using SPSS version 25.0. Descriptive statistics were presented as means, percentages and proportions as appropriate. Chi-square test was used to test the association between categorical variables.

Results

Demographic characteristics of the sample

During the study period, a total of 1,612 blood culture samples had been received by the microbiology laboratory from neonates admitted to the PBU with clinical suspicion of bloodstream infections. From the available data, majority were males (56.7%) and median age was 1 day (IR=4) and age ranges from day one up to 60 days. Of the sample, 99% were aged between 0 and 31 days, while only 1% were aged between 31 and 60 days. From the culture positive cases, 53.8% were males and 46.2% were females.

Neonates had been commonly presented with respiratory distress (14.3%), fever (12.3%), tachypnea (6.32%), grunting (12.9%), reduced activity, poor suckling, weight loss, icteric and jaundice (2%). None of the features were found to significantly associate with clinical features for culture positive suspected sepsis when compared to culture-negative cases.

Factors associated with neonatal sepsis

A total of 69.4% (1103 cases) were early onset (EOS) sepsis cases and 30.6% (487 cases) were late onset sepsis (LOS). Majority (72.8%) were early-onset, culture-negative sepsis. The onset of sepsis (p<0.001) was found to be significantly associated with culture-positive when compared with culture-negative sepsis. Among the total, 93.8% were reported with normal birth weight and 6.2% were with low birth weight. Of normal birth weight and low birth weight neonates, about

88.2% and 11.8% were culture-positive, respectively. Among the total, 335 (20.8%) neonates had been reported to have gestational age less than 37 weeks and 1277 (79.2%) were term babies. Factors like prematurity (p=0.017) and low birth weight (p=0.002), were statistically associated with culture-positivity. (Table 1)

Table 1 Description of baseline characteristics between culture negative and culture-positive cases

	Culture negative		**Culture positive**		***p*-value**
	n	%	n	%	
Sex					
Male	572	57	71	53.8	
Female	431	43	61	46.2	0.480
Onset of sepsis					
EOS	1050	72.8	53	35.6	
LOS	391	27.2	96	64.4	0.001
Birth weight					
LBW	82	5.6	18	11.8	
NBW	1378	94.4	134	88.2	0.002
Gestational age					
Preterm	292	20	43	28.3	
Term	1168	80	109	71.7	0.017
History of premature rupture of membrane					
Yes	11	0.8	3	2	
No	1459	99.2	149	98	0.123

(n=No. of Cases, EOS- Early onset sepsis, LOS- Late onset sepsis, LBW- Low birth weight, NLW- Normal birth weight)

Bacteriological profile of isolated organisms

Of 1612 cultures sent to the laboratory, only 152 cultures showed a positive growth. The overall blood culture positivity rate in this study was 9%. EOS and LOS had 4.8% (53/1103) and 19.7% (96/487) blood culture positivity, respectively. Overall, gram positive organisms (68%) were isolated more frequently than gram negatives.

A total of 152 neonates were found to have blood culture-positive sepsis, of which 125 were positive for bacteremia, 24 were considered possible contaminations and three for fungal sepsis. Gram-negative bacteria accounted for 34.4% (43 cases) and gram-positive organism accounted for 65.6% (82 cases) of sepsis which contributed to 2.6% and 5.1% out of the total suspected sepsis cases, respectively. Different organisms isolated from positive cultures are showed in Table 2.

Coliforms (62.7%) were the most commonly isolated gram-negative organism. Of coliforms 20 cases were lactose fermenting (LF) coliform and

seven were non lactose fermenting (NLF) coliform and 16% and 5.6% from total isolated organisms, respectively. Of LF cases, six cases (30%) were reported as probable *Klebsiella spp.* Of 20 LF coliforms isolated, three (15%) were extended spectrum beta lactamase (ESBL) and two (10%) were multi drug resistant (MDR). About 23.3% (10/43) were *Pseudomonas spp.* among them 20% were *Pseudomonas aeruginosa*. About 11.6% and 2.3% of the gram-negative organisms were *Acinetobacter spp.* and *Flavobacterium spp.,* respectively.

While Coagulase negative staphylococcus (CONS) contributing 78% (64/82), *Staphylococcus aureus* 11% (9/82), *streptococcus spp.* (9.8%) were the common gram-positive organisms isolated and *Enterococcus spp.* 1.2% (1/82) contributed the least. Of nine *Staphylococcus aureus,* four (44.4%) had resistance pattern of MRSA (Methicillin Resistant Staphylococcus aureus) and one had resistance pattern of Methicillin Resistant Staphylococcus aureus + Macrolide Lincosamide Streptogramin B (MRSA+MLSB). From the *streptococcus spp.* six out of eight (75%) were reported as probable group B *streptococcus spp.* and there were one *Streptococcus pneumoniae* and one probable group D *streptococcus spp.*

Table 2 Organisms isolated from positive blood cultures

Isolated micro-organisms	No. of cases (%)
Gram-negative organisms	
LF coliform	20 (16)
NLF coliform	7 (5.6)
Pseudomonas spp.	10 (8)
Acinetobacter spp.	5 (4)
Flavobacterium spp.	1 (0.8)
Gram-positive organisms	
Staphylococcus aureus	9 (7.2)
Coagulase-negative staphylococci	64 (51.6)
Probable group B *Streptococci*	6 (4.8)
Streptococci pneumoniae	1 (0.8)
Probable group D *Streptococci*	1 (0.8)
Enterococcus spp.	1 (0.8)
Total	**125**

(LF Coliform – Lactose fermenting coliform, NLF Coliform – Non lactose fermenting coliform)

Antibiotic susceptibility patterns

Overall, among the gram-negative organisms three (7%) were ESBL producers and two (4.7%) were MDR. Others were sensitive to majority of antibiotics tested. One out of four *Acinetobacter spp.* were carbapenem-resistant *Acinetobacter* (CRAB). About 83.3% of the probable *Klebsiella spp.* isolates were found to be resistant to third-generation cephalosporin and gentamycin but sensitive to amikacin. Of lactose fermenting coliforms 77.8% were sensitive to amikacin and 72% were resistant to gentamycin. Coliforms producing ESBL were sensitive to carbapenems, amikacin. (Table 3)

Table 3 Antibiotic susceptibility and resistance profile of gram-negative organisms

Antibiotics		Coliform LF (%)	Coliform NLF (%)	*Klebsiella spp.* (%)	*Acinetobacter spp.* (%)	*Pseudomonas spp.* (%)	*Flavobacterium spp.* (%)
AK	S	9 (75)	6 (100)	5 (83.3)	5 (100)	8 (88.9)	1 (100)
	R	3 (25)	0	1 (16.7)	0	1 (11.1)	0
AMP	S	0	-	0	1 (100)	1 (100)	-
	R	3 (100)		1 (100)	0	0	
AMC	S	3 (21.4)	6 (85.7)	1 (16.7)	2 (100)	4 (100)	1 (100)
	R	11 (78.6)	1 (14.3)	5 (83.3)	0	0	0
CAZ	S	1 (16.7)	5 (71.4)	1 (16.7)	4 (80)	9 (90)	1 (100)
	R	5 (83.3)	2 (28.6)	5 (83.3)	1 (20)	1 (10)	0
CXM	S	3 (23.1)	1 (16.7)	1 (16.7)	1 (50)	1 (33.3)	1 (100)
	R	10 (76.9)	5 (83.3)	5 (83.3)	1 (50)	2 (66.7)	0
CTX	S	3 (21.4)	3 (42.9)	1 (16.7)	1 (50)	2 (66.7)	1 (100)
	R	11 (78.6)	4 (57.1)	5 (83.3)	1 (50)	1 (33.3)	0
CIP	S	6 (42.9)	4 (80)	1 (16.7)	5 (100)	9 (90)	1 (100)
	R	6 (42.9)	1 (20)	4 (66.6)	0	1 (10)	0
	I	2 (14.3)	0	1 (16.7)	0	0	0
CN	S	4 (33.3)	6 (85.7)	1 (16.7)	4 (80)	9 (90)	1 (100)
	R	8 (66.7)	1 (14.3)	5 (83.3)	1 (20)	1 (10)	0
IMP	S	4 (36.4)	5 (83.3)	1 (25)	3 (75)	2 (100)	-
	R	7 (63.6)	1 (16.7)	2 (50)	1 (25)	0	
	I	0	0	1 (25)	0	0	
MEM	S	5 (55.6)	4 (100)	1 (33.3)	3 (75)	8 (100)	1 (100)
	R	3 (33.3)	0	1 (33.3)	1 (25)	0	0
	I	1 (11.1)	0	1 (33.3)	0	0	0
SCF	S	5 (50)	5 (83.3)	2 (33.3)	4 (100)	5 (100)	1 (100)
	R	5 (50)	1 (16.7)	4 (66.6)	0	0	0
SXT	S	3 (30)	3 (60)	2 (40)	5 (100)	1 (50)	1 (100)
	R	7 (70)	2 (40)	3 (60)	0	1 (50)	0
TZP	S	5 (38.5)	6 (85.7)	2 (33.3)	4 (100)	8 (100)	1 (100)
	R	6 (46.2)	1 (14.3)	4 (66.6)	0	0	0
	I	2 (15.4)	0	0	0	0	

(AK: Amikacin, AMP: Ampicillin, AMC: Amoxicillin clavulanic acid, CTX: Cefotaxime, CIP: Ciprofloxacin, SXT: Cotrimoxazole, CN: Gentamicin, IMP: Imipenem, MEM: Merapenem, CAZ: Ceftazidime, CXM: Cefuroxime, SCF: Cefoperazone sulbactam, TZP: Piperacillin tazobactam, S: Sensitive, R: Resistant, I: Intermediate)

Among gram-positive organisms 13.4% were sensitive to all antibiotics tested and there were no MDR organisms. Out of nine, four (44.4 %) *Staphylococcus aureus* had resistance pattern of MRSA and one had resistance pattern of MRSA+MLSB. Penicillin resistance was noted in isolated *Enterococcus spp.* and probable group D *Streptococci* were sensitive to vancomycin. (Table 4)

Table 4 Antibiotic susceptibility and resistance profile of gram-positive organisms

Antibiotic		*Staphylococcus aureus* (%)	CONS (%)	*Streptococcus pneumonia* (%)	Probable group B *Streptococcus spp.* (%)	Probable group D *streptococcus spp.* (%)	*Enterococcus spp.* (%)
FOX	S	3 (37.5)	19 (31.7)	-	-	-	-
	R	5 (62.5)	41 (68.3)				
DA	S	7 (77.8)	38 (62.3)	1 (100)	3 (50)	0	0
	R	2 (22.2)	23 (37.7)	0	1 (16.7)	1 (100)	1 (100)
	I	0	0	0	2 (33.3)	0	0
E	S	3 (37.5)	17 (27.4)	1 (100)	3 (50)	0	0
	R	5 (62.5)	45 (72.6)	0	1 (16.7)	1 (100)	1 (100)
	I	0	0	0	2 (33.3)	0	0
VA	S	9 (100)	61 (100)	1 (100)	5 (100)	-	1 (100)
	R	0	0	0	0		0
P	S	-	-	1 (100)	6 (100)	1 (100)	0
	R			0	0	0	1 (100)
OX	S	-	-	1 (100)	1 (100)	-	-
	R			0	0		
SXT	S	9 (100)	35 (60.3)	-	2 (100)	-	1 (100)
	R	0	23 (39.7)		0		0
TEC	S	9 (100)	58 (96.7)	-	-	-	-
	R	0	23 (39.7)				
FD	S	8 (88.9)	27 (45)	-	-	-	-
	R	1 (11.1)	33 (55)				
CIP	S	4 (50)	28 (50.9)	-	-	-	-
	R	3 (37.5)	27 (49.1)				
	I	1 (12.5)	0				
CRO	S	-	-	-	4 (100)	0	0
	R				0	1 (100)	1 (100)
CTX	S	-	-	1 (100)	2 (100)	-	-
	R			0	0		
AMP	S	-	-	-	6 (100)	0	0
	R				0	1 (100)	1 (100)

(CONS: Coagulase-negative staphylococcus, FOX: Cefixitin, DA: Clindamycin, E: Erythromycin, V: Vancomycin, P: Penicillin, OX: Oxacillin, SXT: Cotrimoxazole AMP: Ampicillin, CTX: Cefotaxime, CIP: Ciprofloxacin, TEC: Teicoplanin, FD: Fusidic acid, CRO: Ceftriaxone, S: Sensitive, R: Resistant, I: Intermediate)

Discussion

Neonatal sepsis remains a significant cause of morbidity and mortality in newborns, where diagnostic and therapeutic resources may be limited [10,11]. The causative organisms and clinical outcomes of neonatal sepsis is vary by region, hospital setting, and infection control practices [12]. Understanding the local prevalence of blood culture positivity, the spectrum of pathogens involved, and their antibiotic susceptibility patterns is essential for timely and effective empirical therapy. In this study, the proportion of blood culture-positive cases among neonates with suspected sepsis

admitted to the PBU of DGHM was assessed, alongside the associated clinical factors, causative organisms, and their antimicrobial susceptibility patterns. The study was carried out in the microbiology laboratory of DGHM.

Of 1612 blood cultures obtained from neonates admitted to the PBU over the study period, overall blood culture positivity rate was 9%. This is within the range reported in similar studies conducted in neonatal units, which often report positivity rates between 6% and 15% [11,13]. The relatively low positivity could be influenced by several factors, including early empirical antibiotic administration, low blood volume drawn, and the inherent limitations of conventional culture methods [14].

Although majority of suspected cases were classified as EOS (69.4%), culture positivity was higher among LOS cases (64.4% vs 35.6%). Higher prevalence of LOS was also reported by Govindaraju et al. [5] whereas many studies showed higher prevalence of EOS [4,15]. This variation may be results from nosocomial transmission, especially in neonates requiring prolonged hospitalisation or invasive procedures, which are known risk factors for LOS [16]. The higher percent in LOS cases suggests that hospital-acquired infections play a significant role in neonatal bloodstream infections in the PBU setting and require targeted infection control interventions [16,17].

Slight male predominance observed in our study aligns with the findings from several other studies, which have reported higher sepsis incidence in male neonates [4,18]. A study by Verma *et al.* demonstrated that neonatal bloodstream infections were more frequently observed in male infants. This may be due to the presence of genes regulating gamma globulin synthesis on the X chromosome, which may result in comparatively lower immunological protection in males than in females [18].

In the study most neonates presented with respiratory distress, jaundice, and fever similar to other studies [4,18]. According to the available data of this study, none of the potential maternal risk factors were found to be statistically associated with culture positive sepsis. Verma *et al.* showed that premature rupture of membranes, frequent vaginal examination, fever in mother were other important factors predisposing to sepsis [18].

Neonatal factors like preterm delivery (p=0.017), low birth weight (p=0.002), were statistically associated with culture positive sepsis. This finding has been demonstrated in many studies [4,5,9]. A study in India showed preterm babies had more culture positive sepsis [18]. According to Stoll *et al.* neonates with low birth weight are more vulnerable to infections due to reduced levels of IgG [17]. A study done in Bhutan showed that neonates with low APGAR scores, use of total parental nutrition were statistically associated with culture positive sepsis and low APGAR scores act as stress factors which make these neonates more prone to infections because of the poor adaptation to extra uterine life [4].

Regarding microbiological profiles, gram-positive organisms predominated, accounting for 65.6% of the isolates. CONS were the most frequently isolated gram-positive organisms (78%) corroborating findings by Shehab *et al*. [19]. Although CONS are frequently regarded as

contaminants, it could not be ruled out in this study due to the underdeveloped immune systems of neonates and their notable prevalence among symptomatic cases, especially in those with LOS [13,20]. Clinical significance was not mentioned in the laboratory reports. *Staphylococcus aureus*, including methicillin-resistant *S. aureus* (MRSA), and probable Group B *Streptococcus* (GBS) were also observed, supporting global trends of gram-positive cocci being key pathogens in neonatal sepsis [21].

Whereas studies conducted at India and Bhutan showed gram-negative predominance [4,5],in this study coliforms were found to be the most common among gram-negative isolates. With the facilities available microbiology laboratory of DGHM, identification had been done only up to LF and NLF coliforms. Majority were LF coliforms (16%). About 4.8% were reported as probable *Klebsiella* spp. according to the colony appearance. In many studies *Klebsiella* was the most common pathogen in both early and late onset septicemia [5,18, 22].

Antibiotic susceptibility testing revealed considerable resistance among gram-negative isolates to commonly used first-line drugs such as ampicillin and third-generation cephalosporins. However, most retained susceptibility to amikacin and carbapenems. Shehab *et al.* demonstrated that all *Klebsiella* isolates were resistant to ampicillin in their study [19]. A high level of ampicillin resistance was observed among *Klebsiella* isolates in our study, similar to findings from previous studies that reported significant resistance of coliforms [23,24]. In a similar study, high level of resistance was also observed against gentamicin and the organisms were *Pseudomonas spp.* and *Klebsiella spp.* [24]. However, in this study all Pseudomonas spp. Were found to be sensitive to gentamicin. One isolate of *Acinetobacter* was resistant to carbapenems, indicating the emergence of highly resistant nosocomial pathogens even in secondary care settings [25]. Among gram-positive organisms, resistance to oxacillin and erythromycin was noted, but all isolates were susceptible to vancomycin and teicoplanin. Similar to findings from a study conducted by Shehab *et al.* [19] vancomycin remains the drug of choice for MRSA strains in the setup.

These findings emphasise the importance of continuous microbiological surveillance in neonatal units, particularly in resource-limited settings. Empirical antibiotic protocols should be regularly reviewed and tailored according to local resistance patterns. Early identification of at-risk neonates and timely initiation of appropriate antimicrobial treatment are essential to reduce morbidity and mortality associated with neonatal sepsis.

Study had several limitations. Firstly, definitive identification of bacterial isolates to the species level was not possible due to limited diagnostic facilities at the study setting. As a result, the bacteriological profile was reported only up to the group level (e.g., LF coliforms or probable *Klebsiella* spp.), rather than precise species identification.

A uniform antibiotic susceptibility panel had not been used throughout the selected period of January 2021 to December 2022 due to intermittent unavailability of certain antibiotics.

Since this was a retrospective study, there was no opportunity to modify, escalate, or de-escalate antibiotic regimens based on clinical progress or susceptibility results. Additionally, due to the low number of culture-positive cases, it is unable to propose a definitive empirical antibiotic regimen based on our findings.

Moreover, data were collected solely from laboratory records, as access to clinical files or ward records was not available. Consequently, the analysis of associated risk factors was limited to the variables documented in laboratory request forms. The clinical significance of CONS could not be assessed, as determining their pathogenic role requires correlation with clinical presentation, which was not available in the laboratory data.

Conclusion

The overall blood culture positivity rate was 9%, with a predominance of gram-positive organisms, mainly CONS, while lactose fermenting coliforms were the most common gram-negative isolates. High levels of antibiotic resistance were noted, especially among gram-negative bacteria, with marked resistance to ampicillin and third-generation cephalosporins. Vancomycin and amikacin were found to be the most effective agents against gram-positive and gram-negative isolates, respectively. Late onset sepsis was more common than early onset sepsis. Preterm and low birth weight were the factors significantly associated with septicemia.

List of abbreviations

ABST - Antibiotic sensitivity test
CONS - Coagulase negative staphylococci
DGHM - District General Hospital Matara
ESBL - Extended spectrum beta lactamase
EOS - Early onset sepsis
LF Coliform - Lactose fermenting coliform
LOS - Late onset sepsis
MRSA - Methicillin Resistant Staphylococcus aureus
MLSB - Macrolide Lincosamide Streptogramin B
MDR - Multi drug resistant
NICU - Neonatal intensive care unit
NLF Coliform - Non lactose fermenting coliform
PBU - Premature baby unit

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Ethical considerations

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Declaration of conflicting interest

The authors declare that they have no conflict of interest.

Author contributions

MMR collected and analysed the data and drafted the manuscript. SSW contributed to the development of the initial proposal and critically revised the manuscript for intellectual content. AADP sorted and interpreted the data in the microbiology laboratory. All authors read and approved the final manuscript.

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Original Research

Prevalence and Associated Factors of Cognitive Impairment, Depression, and Disability among Older Adults with Chronic Illnesses in Batticaloa, Sri Lanka: A Cross-sectional Study

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Abstract

Older adults with chronic illnesses are at high risk of developing depression, cognitive impairment, and disability. However, limited research has examined the interrelationships between these conditions in post-conflict regions such as Batticaloa, Sri Lanka. This study aimed to assess prevalence and associated factors of depression, cognitive impairment, and disability among older adults with chronic illnesses in Batticaloa, Sri Lanka. A descriptive cross-sectional study was conducted among 427 older adults (≥60 years) with chronic illnesses attending follow-up clinics at Batticaloa Teaching Hospital. Validated assessment tools were used, including the Geriatric Depression Scale, the World Health Organization Disability Assessment Schedule 2.0, and the Montreal Cognitive Assessment. Descriptive statistics were used to summarise the data. Pearson's correlation was applied to assess the associations between depression, cognitive impairment, and disability. Depression was prevalent in 69% of participants, with 22% experiencing severe symptoms. Cognitive impairment and disability were observed in 68% and 86% of participants, respectively. Depression was significantly correlated with disability (r=0.418, p<0.001), while cognitive impairment was negatively correlated with both depression (r=-0.216, p<0.001) and disability (r=-0.305, p<0.001). This study found that depression, cognitive impairment, and disability are highly prevalent among older adults with chronic illnesses in Batticaloa, Sri Lanka. Depression was closely linked to higher levels of disability, while cognitive impairment showed weaker associations with both conditions. The findings point to an urgent need for comprehensive geriatric assessments, community-based rehabilitation programs, and caregiver support mechanisms in Sri Lanka and similar settings.

Keywords: *Aging population, Cost-conflict settings, Functional impairment, Geriatric mental health, Functional impairment*

Introduction

Global health has undergone a significant transition over the past century, shifting from a predominance of infectious diseases to a growing burden of non-communicable diseases. This change in the epidemiology of disease prevalence has been driven by advancements in medical technology, improvements in public health policies, and overall demographic changes in recent years, leading to an increased prevalence of chronic illnesses among older populations [1]. Chronic illnesses such as diabetes, cardiovascular disease, and stroke not only compromise physical health but also negatively impact mental health, contributing to conditions such as depression, cognitive decline, and disability [2]. These adverse effects of chronic illnesses can lead to a loss of independence, a reduced quality of life, and an increased burden on healthcare systems.

As these chronic illnesses may contribute to chronic pain, reduction in mobility, which leads to impairments in functionality, which will ultimately affect individuals' psychological wellbeing. Individuals with chronic illnesses have been reported to have a higher prevalence of depression in ranges between 9.3% and 25% especially those who are diagnosed with hypertension, coronary artery disease, and diabetes [3,4]. As research suggested, depression was associated with a higher risk for cardiovascular risk, which can be both a cause and consequence of cognitive decline and disability [5].

Sri Lankan research highlights the increased prevalence of depression, cognitive impairment, and disability among older adults. When it comes to Jaffna, it has shown that 44.3% of the prevalence of depression, in Galle it is 76% and 31.7% Kandy. Further, the research conducted on disability in Jaffna showed 95.9% of disability prevalence, and in Kegalle, 10% of the older adults reported having difficulties in activities of daily living. Other than that, cognitive impairments are also a pressing concern among this population, where in Jaffna 67.7% [6] reported, and in Galle 80.3% of the individuals reported it. All the higher prevalence suggests that older individuals have higher rates of depression, disability, and cognitive impairment, which can further interfere with their daily living.

As a part of Sri Lanka, which has undergone and been affected by conflict situations and due to that experiencing frequent displacements, bereavements, and also facing numerous socioeconomic problems [9], the Batticaloa District, located in eastern Sri Lanka, remains an underexplored context for examining and assessing these factors. These factors can contribute to increased vulnerability of the individuals residing in this area. Further, the existing literature does not provide any evidence from the Batticaloa District and the interconnection between these different variables. Therefore, this study aimed to assess the prevalence and associated factors of depression, cognitive impairment, and disability among older adults with chronic illnesses attending the follow-up clinic in Batticaloa, Sri Lanka.

Methods

This was a descriptive cross-sectional study. It was approved by the Ethics Review Committee of KIU University (KIU_ERC_2024_410), and institutional approval was also obtained from the hospital. The study was conducted in the medical follow-up clinics at Batticaloa Teaching Hospital, located in the Batticaloa District of Eastern Province, Sri Lanka from August 24 to September 24, 2024. This area presents unique healthcare challenges that significantly impact patient experiences and medical outcomes, as it is an area affected by conflict.

Sample size was calculated using Daniel's formula [10]. The minimum required sample size was 427. Inclusion criteria included the participants of 60 years or older, diagnosed with chronic illnesses for over one year according to medical records, residing in the Batticaloa District, and willing to provide informed voluntary written consent. Individuals with severe sensory impairments or psychiatric disorders were excluded from the study based on clinical records and a basic assessment. The research team developed an interviewer-administered questionnaire including three sections. The questionnaire sought data on demographic information; age, gender, marital status, living arrangements, educational background, and duration of illness etc. The 15-item Geriatric Depression Scale [11], the 12-item World Health Organization Disability Assessment Schedule 2.0 [12], and the Montreal Cognitive Assessment [13] were also used for the study.

The Geriatric Depression Scale has been translated [14] and validated [15] for local use. Previous studies have reported strong reliability for this scale, with Cronbach's alpha of α = .73 [11]. The Geriatric Depression Scale uses a scoring system that ranges from 0 to 15 points. Scores between 0 and 4 were considered normal, indicating the absence of significant depressive symptoms. A score between 5 and 8 represented mild depression. Scores from 9 to 11 signify moderate depression, whereas scores between 12 and 15 are categorized as severe depression.

The Montreal Cognitive Assessment demonstrated exceptional specificity and sensitivity in detecting mild cognitive impairment among the elderly population. This tool has been translated into both Sinhala [16] and Tamil [17]. Previous studies have reported strong reliability for this scale, with Cronbach's alpha of α = .81 [16]. Scores of 24 or higher indicate normal cognitive function. Conversely, scores of 23 or lower were classified as representing abnormal cognitive function, which may suggest potential cognitive impairment.

The World Health Organization Disability Assessment Schedule 2.0 was validated within Sri Lanka, with translations performed in Sinhala and Tamil [6]. Previous studies have reported strong reliability for this scale, with Cronbach's alpha of α=0.92 [18]. The World Health Organization Disability Assessment Schedule presents a five-point categorization of disability. The first level represented no difficulty in functioning. The second level indicated mild difficulty. Moderate difficulty is characterized by a third level. The fourth level signifies severe difficulty. The fifth level represents extreme or complete difficulties in functioning.

Statistical analysis was conducted using SPSS version 25.0 (IBM, New York, United States). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise the demographic, clinical characteristics, and the prevalence of depression, disability, and cognitive impairment. For inferential statistics, Pearson's correlation coefficients were employed to assess the relationships between depression, cognitive impairment, and disability. The significance level of $p<0.05$ was considered statistically significant.

Results

The study included 427 participants with a mean±SD age of 67±6 years, ranging from 60 to 85 years. Females constituted the majority at 67% (n=287). Most participants were married (70%, n=300) and had completed secondary education (38%, n=161). A majority lived with family (75%, n=322), attended the clinic alone (64%, n=271), and traveled 5–20 kilometers to the hospital (62%, n=263). The mean±SD duration of chronic illness was 10 years (±8), with a median of 9 years (IQR: 5–15). Hypertension (56%, n=238) and diabetes mellitus (53%, n=227) were the most prevalent chronic conditions, followed by Chronic Obstructive Pulmonary Disease (13%, n=55) and asthma (7%, n=29). (Table 01)

Among the participants, 69 % (n=291) reported depressive symptoms, categorized as mild (29%, n=124), moderate (18%, n=75), and severe (22%, n=92) (Figure 1). Disability was prevalent among 86% (n=369) of the participants, classified as mild (43%, n=185), moderate (36%, n=152), severe (7%, n=29), and extreme (0.7%, n=3) (Figure 2). As Figure 3 indicates, cognitive impairment was identified in 68% (n=291) of participants.

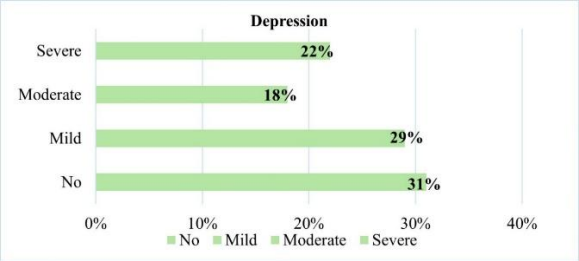

Figure 1 Prevalence of the levels of depression

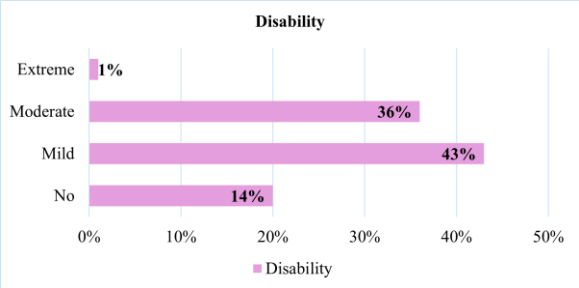

Figure 2 Prevalence of the levels of depression

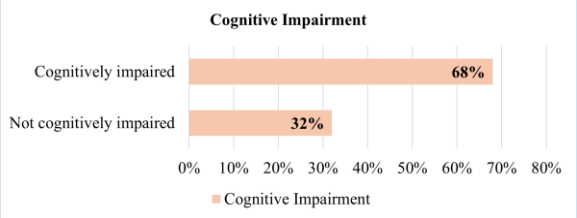

Figure 3 Prevalence of cognitive impairment

Table 01 Demographic details of the participants (n=427)

Type	n (%)
Mean age (±SD)	67 (±6)
Gender category	
Male	140 (33)
Female	287 (67)
Marital status	
Single	42 (10)
Married	300 (70)
Widowed	73 (17)
Separated	12 (3)

Educational level	
No formal education	98 (22)
Primary education	139 (33)
Secondary education	161 (38)
Tertiary education	29 (7)
Living arrangements	
Alone	102 (24)
With family	322 (75)
Other	3 (1)
With whom patients come to the clinic	
Alone	271 (64)
With family	156 (36)
Distance traveling to the hospital	
Less than 05 km	92 (22)
5-20 km	263 (62)
More than 20 km	72 (16)
Disease characteristics	
Hypertension	238 (56)
Diabetes Mellitus	227 (53)
COPD	55 (13)
Asthma	29 (7)
Chronic Illness Duration Mean±SD	10 (±8)

Table 02 Pearson's Correlation Coefficients among Disability (DIS), Depression (Dep), and Cognitive Impairment (CI) Levels

	Dis Level	**Dep Level**	**CI Level**
Dis Level	1		
Dep Level	.418**	1	
CI Level	-.305**	-.216**	1

*** Correlation is significant at the 0.01 level (2-tailed).*

Among the sociodemographic factors, age showed significant positive correlations with depression (r=0.451, p<0.001) and disability (r=0.277, p<0.001), while demonstrating a weak negative correlation with cognitive impairment (r= -0.177, p<0.001). Regarding disease-specific factors, hypertension was negatively correlated with both disability (r= -0.244, p<0.001) and cognitive impairment (r= -0.291, p<0.001), possibly suggesting that individuals with well-managed hypertension may experience fewer limitations in these domains. Additionally, the duration of chronic illness was positively correlated with depression (r=0.216, p<0.001) and disability (r=0.130, p=0.007), highlighting the cumulative psychological and functional burden associated with long-term illnesses.

Discussion

The study involved 427 participants with a mean age of 67 years, the majority of whom were female. Most participants were married and had completed secondary education. A significant proportion of participants lived with family and traveled between 5 and 20 kilometers to reach the hospital. Hypertension and diabetes mellitus were the most prevalent disease conditions, with a mean duration of illness of 10 years. Further, this study identified a higher proportion of individuals who had undergone depression, disability, and cognitive impairment. Further, cognitive impairment showed a negative correlation with both depression and disability. Other than that, sociodemographic factors like age, marital status, and disease-related factors like illness duration were further found to have an association with these three variables.

The higher prevalence of depression (69%), identified in this study, can be due to the different factors in relation, such as chronic illnesses, sociodemographic factors, which can ultimately

increase the burden among the individuals. This finding aligns with the common statement that individuals with chronic illnesses are prone to depression [19], which can be influenced by various factors. These findings are also consistent with the other studies related to Sri Lanka. For instance, a study conducted in Jaffna showed a depression rate of 44% [6], and in Galle, reporting 76% and further in Kandy, it has been reported as 31.7%. These differences in the rates of depression among individuals can be due to healthcare accessibility and the socio-cultural aspects of the region.

The higher prevalence of reported cognitive impairment observed (68%) may be due to the interaction between cognitive decline as a result of aging and chronic health conditions. Similarly, 67.4% of the prevalence of cognitive impairment was reported in Jaffna [6], and in Galle it was reported as 80.3% [7]. These findings highlight that cognitive impairment is a common issue among older individuals with chronic illnesses, highlighting the role of chronic illnesses in increasing cognitive decline.

In this study 86% of the individuals reported some level of disability, which indicates a higher prevalence of impairment in functional abilities among the studied population. As per the previous studies, which were conducted, in Jaffna it reported that disability levels among the elderly were as high as 95.9%, reflecting a profound degree of dependence on daily functioning [6]. Further, another study reported 86.4% of participants had any form of disability, giving insights into the caregiver burden and higher psychosocial impact on individuals [20].

There was a significant positive correlation observed between depression and disability, and these findings are similar to the previous studies, which have shown that depression symptoms can increase functional disability among older adults. Research has demonstrated that depression in elderly individuals can contribute to functional impairment, particularly in those with chronic conditions, as depression often leads to decreased motivation, lack of energy, and poor health behaviors [15]. Similarly, a study found that depressive symptoms significantly increased the risk of disability among elderly populations, further supporting the present findings [21].

Age significantly influenced the mental and physical health outcomes of the participants. A positive correlation was observed between older age and both depression ($r=0.451$, $p<0.000$) and disability ($r=0.277$, $p<0.000$), consistent with the established decline in physical and mental health that accompanies aging [22]. These associations suggest that as individuals grow older, they may experience greater emotional distress and physical limitations, potentially due to accumulating health conditions, reduced mobility, social isolation, and the psychosocial stressors linked to aging. Interestingly, there was a weak negative correlation between age and cognitive impairment ($r= -0.177$, $p<0.000$), indicating that older participants were somewhat less likely to exhibit severe cognitive impairment. This could be due to several factors, such as survival bias where individuals with preserved cognitive function are more likely to live into older age.

In terms of disease-specific factors, hypertension demonstrated a negative correlation with both disability and cognitive impairment. These

findings indicate that effective management of hypertension may help reduce the risk of functional and cognitive decline [23]. Prior research supports this notion, showing that controlling blood pressure can slow the progression of cognitive impairment and physical disability in elderly patients [24]. Furthermore, the positive correlations between the duration of chronic illness and both depression (r=0.216, p<0.000) and disability (r=0.130, p=0.007) emphasize the cumulative psychological [25] and physical burdens [26] associated with long-term illnesses. This underscores the importance of early intervention and ongoing care to effectively manage these complex conditions.

A notable strength of this study is its focus on a conflict-affected region, which provides critical insight into the psychological and functional health challenges of an underserved and often overlooked population. The study contributes to the limited body of evidence on how sociodemographic and disease-specific variables relate to mental health outcomes such as depression, disability, and cognitive functioning in this unique context. The use of standardized and validated measurement tools enhances the reliability of the findings, while the relatively large sample size improves the statistical power and generalizability of the results within the studied area.

However, the study also has several limitations. The cross-sectional design restricts the ability to establish causality between the observed variables. The use of a convenience sampling method may introduce selection bias and limit the generalizability of the findings beyond the selected regions. Additionally, although efforts were made to include Tamil-speaking participants, language barriers and cultural differences may have influenced the accuracy of self-reported responses. Lastly, the reliance on self-report questionnaires could be subject to recall bias and social desirability bias, particularly in assessing sensitive topics such as mental health. Future studies employing longitudinal designs and more representative sampling strategies are recommended to confirm these findings and better understanding of the temporal relationships among chronic illness, psychological wellbeing, and functional status in conflict-affected settings.

Conclusion

This descriptive cross-sectional study highlighted the high prevalence of depression (69%), disability (86%), and cognitive impairment (68%) among older adults with chronic illnesses attending follow-up clinics in the Batticaloa District. The findings revealed notable associations between depression and disability, as well as inverse relationships between cognitive impairment and both depression and disability. Increasing age and longer illness duration were significantly associated with greater levels of depression and disability. Moreover, sociodemographic factors such as gender and living arrangements were found to be related to severe depression. The observed associations underscore the importance of further longitudinal and interventional research to explore the underlying mechanisms and potential strategies to support psychological and functional wellbeing in this population.

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Ethical considerations

This study was approved by the Ethics Review Committee of KIU University (KIU_ERC_2024_410) on September 19, 2024

Declaration of conflicting interest

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Author contributions

KNR and HSS supported the study design and provided contextual and methodological insights during data interpretation. KNR and HSS were involved in the overall study conception and design, oversight of study implementation, and provision of methodological guidance to field coordinators. KNR critically revised the manuscript for intellectual content. JKV, SMIE, KHSDS, WMAP, and HMKSS were responsible for data collection. KNR and HSS facilitated access to the data collection settings. All authors read and approved the final manuscript.

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Original Research

Caregiver Burden and Quality of Life among Family Caregivers of the Elderly in Nuwara Eliya District, Sri Lanka: A Cross-sectional Study

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Abstract

Family caregivers, often lacking financial, social, and psychological support, bear the primary responsibility for elderly care. Rapidly aging population of Sri Lanka has intensified the demand for family caregivers in eldercare, particularly in rural areas where institutional support is limited. This study aimed to assess the caregiver burden and quality of life (QoL) among family caregivers in the Nuwara Eliya District, Sri Lanka. A descriptive cross-sectional study was conducted in two selected Medical Officer of Health areas in Nuwara Eliya. Data were collected using a pre-tested interviewer-administered questionnaire. The sample included 166 caregivers selected via convenient sampling. The questionnaire comprised three sections: demographic characteristics, caregiver burden assessed using the Sinhala-translated Zarit Caregiver Burden Interview, and QoL measured with the Sinhala-translated Adult Carer Quality of Life Questionnaire. Data were analysed using SPSS version 25.0, applying descriptive and inferential statistics to identify associations between caregiver burden and sociodemographic factors. The mean (±SD) age of caregivers was 51±11 years, with 69% being female. The caregiver burden was negatively correlated with QoL (p<0.01). Moderate to severe caregiver burden was reported by 58%, while 68% reported a mid-level QoL. Higher QoL was linked to Sense of Value (41%) and Support for Caring (35%), whereas financial strain and caregiving stress were major concerns. The caregiver burden was significantly associated with caring choice (p<0.01), caring stress (p<0.01), money matters (p<0.05) and sense of value (p<0.05). Quality of life was significantly associated with support for caring (p<0.01), caring choice (p<0.01), caring stress (p<0.01), financial matters (p<0.01), sense of value (p<0.01). Caregivers in rural Sri Lanka experienced moderate to severe burden, with most reporting a mid-level quality of life. The caregiver burden was negatively associated with QoL. Higher QoL was associated with social support and a sense of value, while financial strain and caregiving stress were major concerns. These findings highlight the urgent need for culturally appropriate interventions that offer emotional, financial, and practical support to caregivers.

***Keywords**: Caregiver burden, Informal family caregivers, Quality of life*

Introduction

Sri Lanka is undergoing a fast demographic transition, where the percentage of the elderly population is more than 12% of the total population [1]. Aging makes the older population prone to a variety of aging-related complications such as disabilities and chronic diseases, resulting in increased dependency among the elderly. To the majority of families, the biggest challenge is providing caregiving within the home, where family caregivers have a significant load for the older adults residing in their homes, particularly in areas like Nuwara Eliya [2]. Institutional care for older people in these areas has the caregiving responsibility largely on family caregivers, who have a lack of sufficient financial resources and weak social and psychological support [3]. Although Sri Lankan culture has always valued and promoted the tradition of caregiving, the growing demands and complexity of eldercare are exposing informal family caregivers to higher vulnerability in experiencing issues in their physical and mental health and with current economic cost, eventually impacting their quality of life (QoL).

Informal carers, primarily family members, constitute a vital resource in the care of older persons in activities of daily living, their medical conditions, and mental health [4]. This caring role, however, frequently translates into burden in terms of emotions, physical demands, and economic costs on the carers [2,4]. Research has shown that these caregivers tend to experience high levels of psychological distress, such as anxiety, depression, and burnout, because they handle work, domestic, and social responsibilities which tend to adversely affect their own quality of life [4]. Because informal caregiving has multiple factors involved and there are no proper support systems available which may have an unfavorable impact on the quality of life of the informal caregivers of Sri Lanka. The burden that caregivers face is described as a cumulative response to the stresses a caregiver experiences alongside the challenges of looking after a dependent [5]. The informal caregiver burden problem brings in its own set of demographical and social challenges. This is especially true, as most informal family caregivers lack some knowledge concerning the caregiving process, suffer from some financial hardship, and face difficulty in obtaining appropriate healthcare services [6].

Moreover, social expectations in some cultures, a given social support network, and the self-resilience of the individual markedly alter the degree of caregiver burden [7]. For instance, Asian culture places a lot of emphasis on family participation in caregiving, which elevates burden [8]. In Sri Lanka, a Jaffna study also pointed out the contribution of family members to the care of older people. Caregiving is part of their culture and is viewed as a cost they pay for the wellbeing of their loved ones, particularly due to the poor government support for elder care in the region [9].

Though Sri Lanka has an escalating population of elderly persons [1], the country lacks a formal support and education system for informal carers who primarily care for the elderly. Therefore, these informal carers may have difficulties in adapting to disease conditions, which negatively affect both the physical and mental health of the carers and the caregivers [1]. Furthermore, the

majority of informal carers perceive caregiving as an obligation they must reconcile, and in doing so, they can gain a sense of meaning and responsibility due to ingrained cultural expectations. This may lead to unrecognised stress and self-sacrifice among family caregivers. Some studies have shown that, although the caregivers may find their role rewarding, they continue to be tired and socially isolated due to caregiving pressures [8]. Gender disparities in caregiving also usually emerge, and social expectations have mainly allocated the care responsibility to women.

Therefore, there is an increased need to assess the caregiver burden of informal caregivers, especially in districts like Nuwara Eliya. Determining the levels of caregiver burden and quality of life is of great importance in the development of effective interventions to decrease the burden and promote the wellbeing of caregivers. Therefore, the present study was carried out to assess the levels of caregiver burden and quality of life in older adult family caregivers of Nuwara Eliya District, Sri Lanka.

Methods

A quantitative approach was utilised in this descriptive cross-sectional study. Ethical approval for the study was obtained from the Ethics Review Committee of KAATSU International University (KIU_ERC_2024_205) and institutional approval was obtained from the Regional Director's Office of Nuwara Eliya District. The research was conducted in two selected Medical Officer of Health (MOH) areas: Ambagamuwa and Walapane under the Nuwara Eliya District, Sri Lanka. Data collection was completed within two weeks, from the 13th to the 27th of November 2024, by home visiting informal caregivers within the MOH areas.

The sample size was calculated using Daniel's formula [11]. Sampling was conducted using convenient sampling. The original target was 411 participants, however, the actual sample consisted of 166 caregivers due to the limited number of caregivers. Informal caregivers were first identified through home visits made by the researchers. Homes containing elderly bedridden adults and identifying the lead informal caregiver having cared for at least six months were selected through these visits. Researchers explained the purpose of the research and obtained informed consent from those participants who were willing to participate. Data were collected using a pre-tested, interviewer-administered questionnaire with three sections. The first section assessed demographic variables, including age, educational attainment, and economic status. The second section assessed caregiver burden using the Sinhala translation (Written communication, the 10/66 Dementia Research Group-Sri Lanka, May 2023) of the Zarit Caregiver Burden (ZBI) Questionnaire [5], which contained 22 items. The third phase measured quality of life using Sinhala translation of the Adult Carer Quality of Life Questionnaire (AC-QoL) [12] with 40 items and eight subscales.

ZBI is a widely applied self-reporting subjective care-burden measure among carers [5] and has been translated and adapted into Sinhalese for application in Sri Lanka [1]. It consists of 22 items, with a scoring of 0-4 per item. All the items are measured using a 5-point Likert scale. Item scores can be summed up to yield an overall 0-

88, with higher scores indicating higher burden. 0-20 indicates 'little or no burden', 21-40 'mild to moderate burden', 41-60 'moderate to severe burden' and 61-88 'severe burden', respectively. A score of 24 or more indicates high risk of depression in the carer.

Sinhala-translated Adult Carer Quality of Life (AC-QoL) scale [12] was employed within this study. The instrument was pre-tested on 20 family carers to ensure it was as understandable as possible. The instrument consisted of items which fell into eight subscales: carer stress, financial impact, personal wellbeing, support for caring, carer satisfaction, relationship with the care recipient, impact on personal time, and perceived social support. The AC-QoL is made up of 40 four-point scale items (0 = "never"; 1 = "some of the time"; 2 = "a lot of the time"; 3 = "always"), grouped in eight subscales: support for caring (items 1–5), caring choice (items 6–10), caring stress (items 11–15), financial matters (items 16–20), personal growth (items 21–25), sense of value (items 26–30), ability to care (items 31–35), and carer satisfaction (items 36–40). Total scores range from 0 to 120, and poor quality of life is scored 0–40, moderate quality of life 41–80, and good quality of life a score of over 80. Individual subscales also have a range of 0 to 15, with higher scores indicating improved quality of life within that particular area. A range of 0 to 5 represents a poor quality of life, which may translate to difficulties, 6 to 10 represents a mid-quality of life, and 11 or more represents a good quality of life on the subscale.

Data collected were statistically analysed with the help of SPSS Statistics version 25.0. Descriptive statistics including frequencies, percentages, means, and standard deviations were used in summarising demographic and caregiving-related variables. Normality of data was tested by Kolmogorov-Smirnov test, which revealed non-normal distribution of Zarit Burden Interview Questionnaire (ZBI) and Quality of Life (QoL) scores (p<0.05). Therefore, inferential analysis with non-parametric statistical tests was performed. Spearman's correlation test was used to examine the correlation between caregiver burden, QoL, and subscales of the AcQoL. A significance level of p<0.05 was considered as statistically significant.

Results

The mean ±SD age of the caregivers was 51±11 years. The sample included more women (n=115, 69%) than men (n=51, 31%). Most participants were Buddhists (n=157, 95%) and married (n=150, 90%). Economically, half of them were unemployed (n=84, 51%). Most were educated up to G.C.E O/Ls (n=100, 60%), and most had an income of between 10,000 to 100,000 LKR monthly (n=110, 66%). (Table 01)

Concerning the involvement of care recipients, 30% (n=52) of the caregivers reported that they were caring for their mother. Most of the caregivers (n=91, 55%) had been caring for less than five years, and 42% (n=70) reported caregiving for 1–5 years. The mean±SD caregiving hours per week were 31±24. (Table 01)

The caregiver burden (mean±SD) and quality of life was 41±7 and 72±1, respectively. The most significant caregiver burden was moderate to severe (n=97, 58.4%), followed by mild to moderate burden (n=68, 41%). (Table 02). In the case of quality of life, the majority of the

caregivers (n=112, 68%) had a mid-range quality of life, and 28% (n=47) had a high quality of life. (Table 02)

Table 01 Demographic details of the participants (n=166)

Variable	Frequency n (%)
Age (mean±SD)	51±11
Gender category	
Male	51 (31%)
Female	115 (69%)
Ethnicity	
Buddhist	152 (92%)
Hindu	6 (4%)
Islam	3 (2%)
Catholic	5 (3%)
Marital status	
Married	150 (90%)
Unmarried	13 (8%)
Widowed	3 (2%)
Educational level	
No formal education	22 (13%)
Up to G.C.E. O/L	100 (60%)
Up to G.C.E. A/L	38 (23%)
Graduate	6 (4%)
Occupation	
Government	14 (8%)
Private	19 (11%)
Self employed	49 (30%)
Unemployed	84 (51%)
Monthly income (LKR)	
<10000	49 (30%)
10000 – 100000	110 (66%)
>100000	7 (4%)
Characteristic of caregiving	
Relationship with carer	
Mother	51 (31%)
Father	38 (23%)
Spouse	30 (18%)
Children	1 (1%)
Other	46 (28%)
How long have you been caring	
<1 year	91 (55%)
1-5 year	70 (42%)
5-10 year	5 (3%)
Hours spent caring mean per week (mean±SD)	31±24

Able to Care (69%), Personal Growth (69%), and Caring Stress (61%) comprised the highest percentage of respondents in the mid-QoL range. On the other hand, Sense of Value (41%) and Support for Caring (35%) comprised the highest percentage of respondents in the high-QoL range. Similarly, Caring for Choice (35%) and Financial Matters (34%) also comprised a high percentage of respondents reporting high QoL (Figure 01)

Table 02 Caregiver burden and quality of life

Variable	Mean ± SD	Category	Frequency n (%)
Caregiver burden	41±7	No to Mild	1 (1%)
		Mild to Moderate	68 (41%)
		Moderate to Severe	97 (58%)
Quality of life	72±1	Low QoL	7 (5%)
		Mid-range QoL	112 (68%)
		High QoL	47 (28%)

In contrast to this, Carer Satisfaction (9%), Caring for Choice (9%), and Ability to Care (10%) had the lowest sample percentage in the low-QoL category. However, Caring Stress (17%), Support for Caring (17%), and Financial Matters (14%) had slightly larger percentages in the low-QoL category. (Figure 01)

The correlation revealed a statistically significant negative correlation (r = -.250, p<0.01) between total Quality of Life (QoL) and total Zarit Burden Interview Questionnaire (ZBIQ). Moreover, total caregiver burden (ZBIQ) was significantly correlated with caring stress (p<0.01) and caring choice (p<0.01) and inversely related to sense of value (p<0.05) and financial matters (p<0.05). The overall quality of life (QoL) was strongly associated with support for caring (p<0.01), choice to care (p<0.01), stress in caring (p<0.01), money (p<0.01), personal growth (p<0.01), sense of worth (p<0.01), being able to care (p<0.01), and satisfaction in carers (p<0.05).

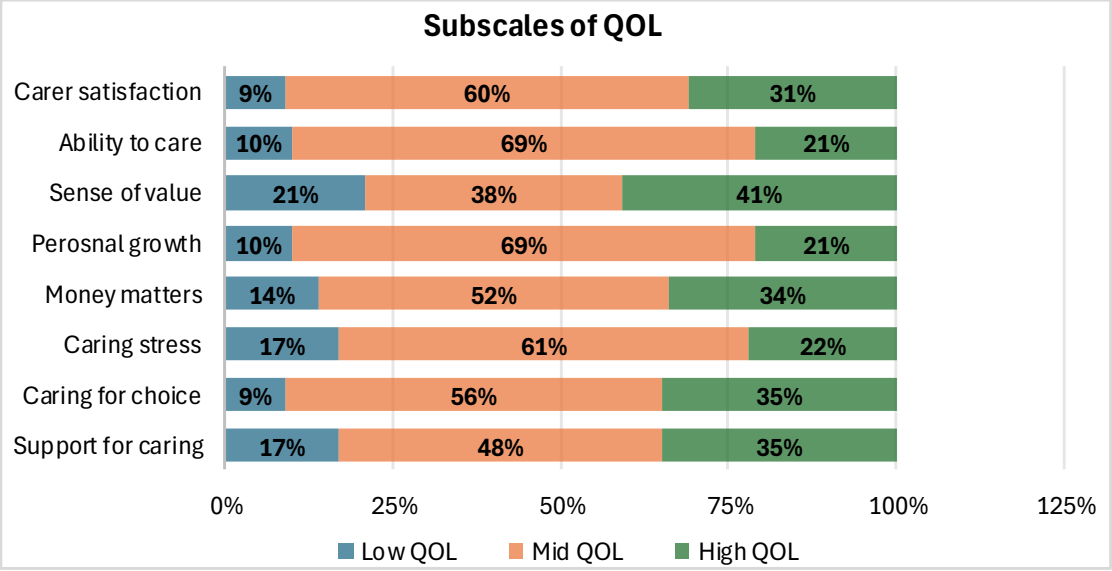

Figure 01: Distribution of sub-scale QoL levels

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Table 03 Association of caregiver burden and quality of life (n=166)

Variables	1	2	3	4	5	6	7	8	9	10
1. Total ZBIQ value	—									
2. Total QoL value	–.250**	—								
3.Support for Caring	–.118	.701**	—							
4.Caring Choice	.253**	.255**	.140	—						
5.Caring Stress	.336**	.440**	.231**	.284**	—					
6.Money Matters	–.173*	.700**	.490**	.088	.425**	—				
7.Personal Growth	–.038	.574**	.236**	–.108	.115	.279**	—			
8.Sense of Value	–.183*	.770**	.510**	–.068	.148	.453**	.561**	—		
9.Ability to Care	–.134	.441**	.193*	.020	.068	.208**	.325**	.287**	—	
10.Carer Satisfaction	–.140	.176*	–.017	.007	–.087	–.071	.163*	.174*	.210**	—

Note: Spearman's rho coefficients are reported. *ZBIQ = Zarit Burden Interview Questionnaire Total; QoL Total = Quality of Life. p*<0.01**; *p*<0.05*

Discussion

This study found that middle-aged women, mostly Buddhists, made up the majority of carers. A significant number of these women were unemployed and had only completed G.C.E O/L. The majority of carers have spent 31 hours a week on average taking care of their parents. The results showed a mid-range quality of life and a moderate to severe caregiver burden, with social support, financial security, and stress all being important factors in their wellbeing. Furthermore, quality of life and caregiver burden were significantly correlated negatively. Higher quality of life scores were also positively correlated with social support, financial stability, and a sense of worth in providing care. Reduced quality of life was associated with carer stress and financial difficulties.

The current study findings are consistent with those of earlier research that found similar sociodemographic outcomes in different settings. The family structure and cultural customs in Sri

Lanka, where providing care is socially normalised as a female role, could be responsible for the study's finding that 69% of carers were women. Furthermore, the greater percentage of women who are carers may be explained by the fact that they are less likely to be employed in the area, which enables them to take on domestic duties more easily. The results of a study carried out in the Batticaloa District, which also discovered that more women were taking on caregiving, are in line with this finding [13].

Wives (21%) and daughters (38%) were likewise the most common caregiver types in this study, reflecting again women's burden of responsibility from marital and family obligations that is a usual attribute in Sri Lankan society. The observation of wives and daughters as the most common caregiving types has also been observed in other previous research [1]. This gender disparity has also been evidenced in foreign literature, describing the influence of conventional assumptions concerning gender roles in dividing the caregiving responsibilities unevenly between the sexes [7, 10].

The study also found that 51% of carers were unemployed, which may indicate that caregiving obligations can interfere with one's ability to do their job. This may be because of the time required for caregiving, which is further exacerbated by the lack of an efficient support system, which forces caregivers, mostly women to quit their jobs. This result is also in line with earlier research that found that carers frequently experience work disruptions, which leads to both financial strain and insecurity [14]. Additionally, it was shown in a Chinese study that carers experience a higher financial burden as a result of their intense caregiving responsibilities and work commitment [15]. Economic burden to caregivers in Sri Lanka is also increased by the absence of institutional eldercare services, which places even greater pressure on informal caregivers to remain at home and care.

The educational level of the caregivers is also an important demographic attribute observed in the current study, with most caregivers (60%) having attained only secondary-level education. This could be due to the socio-economic level of the area, such that access and support for higher education is scarce. This supports the findings of a previous study, where 69% of the caregivers had a GCE O/L level of education [10]. Low levels of education among informal caregivers are a problem for their ability to follow medical orders, access appropriate health care, and advocate for care recipients in situations of need. This is an important issue seen in most low- and middle-income countries, where low educational levels are associated with low health literacy and poorer caregiving skills [16].

Besides, this research revealed that 58% of the informal caregivers had a moderate to high burden. The high burden can be caused by many factors, such as the exhaustive responsibility of caregiving, lack of support systems, physical and emotional exhaustion as a result of long-term caregiving. Another Sri Lankan study also found that 62% of caregivers had a moderate burden [10]. In one other study, 26% were found to have moderate to severe burden and 42.9% with mild to moderate burden according to the ZBI scale [1]. The caregiver burden was lower in Nepal [3] and China [17], perhaps because more potent community support systems exist in these

settings. These differences can also be seen as a reflection of the effects of socio-economic and cultural determinants on the lives of the caregivers.

Caregiver burden can also be seen to have a detectable impact on the QoL of caregivers. In this study, 67% of the caregivers reported an average QoL, and 4% had a low QoL. The study also observed that QoL was negatively correlated with caregiver burden. The results presented here highlight the significant impact caregiving burden can have on QoL, primarily due to the psychological and emotional aspects of caregiving and without coping abilities or facilities. More emotional issues in 90% of the caregivers were reported in one study as a result of caregiving [18]. Informal caregivers were reported to have poor QoL, particularly in mental health, in another study due to stress and emotional issues they went through [3]. It is thus evident that caregiving impacts the caregivers considerably and indicates the need for particular interventions to empower and support them.

In the present study, the majority of the caregivers had a moderate quality of life, particularly in ability to care subscale, personal growth, and stress of caring. This suggests that even though the caregivers are successful in their caregiving tasks, they are still experiencing a great deal of stress. Further, the QoL scores were enhanced in the sense of value subscales and caring support, indicating that most caregivers derive gratification from caregiving tasks and receiving care significantly enhances their quality of life. The fact that most caregivers in this study perceived a greater sense of value is akin to [19], where caregivers perceived positive feelings such as happiness and gratitude. This can also be because Sri Lanka has high family bonds, which are resilience factors, and thus a greater sense of worth in caregiving. The ‘money matters’ theme of the QoL subscale and care stress, however, had vast differences at varying levels of QoL.

The current research gives a new perspective on the challenges faced by informal caregivers in Nuwara Eliya. The research also identifies culturally relevant demographic data and caring patterns, which render the results more applicable to the Sri Lankan context. The results demonstrate the need for the implementation of caregiver educational programs to promote health literacy among informal family caregivers. In addition, the research determines the major factors to be taken into consideration when attempting to improve a caregiver's quality of life. The focus on gender distinction also suggests that interventions must be gender-specific based on the caregiver's gender. The results also suggest some policy modifications that should be established to improve the general wellbeing of caregivers and care recipients.

However, there are a few limitations that should be mentioned. The reliance on self-reported data can lead to bias. Furthermore, since this study aimed at one area in Sri Lanka, generalization may be limited, as patterns of caregiving vary across different regions of the country. The cross-sectional design does not enable causal conclusions, and variation in caregiver experience by coping strategies or presence of extended family support was not explored in detail. Also, the inability to achieve the required sample size due to purposive sampling results in bias data interpretation. Completing these gaps

with mixed-method and longitudinal research would provide an improved understanding.

Future research must come to grips with interventions such as community-based respite care, financial support, and rural caregiver mental health services. Longitudinal studies could track the impact of caregiving on health status as it changes over time, and telemedicine and mobile health app studies could offer new solutions. The inclusion of urban caregivers in studies would allow for comparison, and policy-oriented research on workplace support and social welfare policies could inform national strategies to enhance caregiver wellbeing.

Conclusion

This study assessed the caregiving burden and QoL of older persons' caregivers in the Nuwara Eliya District, Sri Lanka. The results showed that most caregivers were unemployed, middle-aged females with moderate to high burden and mid-range quality of life. Caregiver burden negatively correlated with QoL. Overall, emotional satisfaction and external support subscales of QoL were more likely to be associated with improved QoL, and financial hardship was a longstanding issue. These findings highlight the urgent need for culturally appropriate interventions offering emotional, financial, and practical support to caregivers. Management of these complex factors is important for improving caregiver wellbeing and informing supportive policies and services.

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Ethical considerations

This study was approved by the Ethics Review Committee of KIU University (KIU_ERC_2024_205) on July 14, 2024.

Declaration of conflicting interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author contributions

KNR and HSS supported the study design and provided contextual and methodological insights during data interpretation. KNR and HSS were involved in the overall study conception and design, oversight of study implementation, and provision of methodological guidance to field coordinators. KNR critically revised the manuscript for intellectual content. MIT, SRM, MCD, SKG, and KKK were responsible for data collection, while KNR and HSS facilitated access to the data collection settings. All authors read and approved the final manuscript.

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Original Research

Awareness about Dental Fluorosis among Parents of School Children in Selected Schools in Dimbulagala Educational Zone, Polonnaruwa District, Sri Lanka

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Abstract

Dental fluorosis (DF) is a preventable, common oral health problem characterised by abnormalities in the formation of the enamel structure resulting from repeated exposure to high quantities of fluoride, during critical stage of tooth development. This is the most prevalent among children aged 12-15 years, particularly in regions of Asia and Africa where groundwater contains naturally high levels of fluoride. Parental awareness plays a crucial role in the prevention and early detection of DF, as an essential focus in improving the oral health of children. This study was designed to assess the parental awareness about DF and its associated factors among school children in selected schools in Dimbulagala Educational zone, Polonnaruwa District, Sri Lanka. A descriptive cross-sectional study was conducted among 273 parents of the school children, aged 12-14 years in Dimbulgala Educational zone. Students were selected using multi-stage cluster sampling method and data were collected using a self-administrated questionnaire. Data were analysed using SPSS version 26.0. A greater proportion of the parents (n=154 (56.4%) were female and most of the parents were engaged in farming (n=127, 46.5%). A significant proportion of them (n=267, 97.8%) lived in rural areas. Overall, parental awareness of DF was low. Little more than half of the parents (61.9%) were unaware of DF and the role of fluoride as its primary cause. A majority (86.8%) did not know that fluoride was present in their drinking water and toothpaste. Similarly, most parents (n=230, 84.2%) were unaware that excessive fluoride exposure is the main factor contributing to DF. Furthermore, 44.7% of the participants (n=122) were not aware of water sources with high fluoride concentrations. Although no statistically significant association was found between DF awareness and socio-demographic characteristics such as age, gender, and monthly income, there was a significant association between awareness of DF and both the area of residence and parents' occupation. This study highlights a low level of parental awareness regarding DF including its causes, and the presence of fluoride in commonly used sources. Despite no significant association were observed between awareness and socio-demographic factors such as age, gender or income, significant associations were found with parental occupation and rural residence. Therefore, targeted public health interventions, particularly in rural communities to enhance parental knowledge are essential for the prevention and early identification of DF, ultimately contributing to improved oral health in children.

***Keywords**: Dental fluorosis, Parental awareness, School children*

Introduction

Dental fluorosis (DF) has become a major public oral health problem in many developing countries, despite being a preventable condition [1]. It is characterised by abnormalities in the formation of tooth enamel due to repeated exposure to high levels of fluoride, particularly during the tooth development stage. This excessive fluoride intake reduces the mineral content of enamel and increases its porosity, leading to tooth discoloration [2]. Depending on the severity, DF can be classified as mild, moderate, or severe. Although DF alters the appearance of the enamel, it does not typically affect normal dental function. However, while DF is often considered a cosmetic issue, it may indicate excessive fluoride exposure that can lead to systemic fluorosis. Systemic fluorosis is associated with serious health consequences, including an increased risk of bone fractures, certain cancers, thyroid dysfunction, infertility, weakened immune function, and impaired cognitive development [3].

Mild dental fluorosis is the most common form and typically appears as opaque white spots or streaks on the tooth enamel. These changes may go unnoticed without a professional dental examination. At this stage, small bright white flecks and patches can be seen on the enamel. Moderate fluorosis is more easily identified, as it presents with yellowish or light brown stains and more noticeable discoloration. Severe fluorosis, though rare, is characterised by poorly formed enamel with visible pitting, rough texture, and dark brown staining that may worsen over time [4]. Without proper awareness and knowledge of fluorosis, even moderate and severe cases can go undiagnosed. Fluorosis can present with a range of enamel changes, including stains from yellow to dark brown, surface irregularities, and pits [5]. Importantly, DF is not considered a disease but rather a cosmetic condition that primarily affects oral health [6].

Although the global prevalence of DF is not precisely established, many countries across Africa, America, the Middle East, and Asia report endemic levels of both dental and skeletal fluorosis, primarily due to fluoride concentrations exceeding 1.5 mg/L in drinking water. It is estimated that approximately 25 million people currently have DF, and around 66 million are at risk of developing the condition. More than 23 countries are known to have endemic fluoride levels in their water sources, with nearly 100 million people affected worldwide, as fluoride remains the major contributing factor to fluorosis [7]. Regions such as Asia and Africa are particularly vulnerable due to naturally high fluoride concentrations in groundwater. In high-fluoride villages, the prevalence of DF among children ranges from 30% to 94%, with the highest rates observed among those aged 12 to 15 years. In some areas, nearly two-thirds of school-aged children are affected by DF [8].

In Sri Lanka, the distribution of fluoride in groundwater varies significantly by region, with higher concentrations commonly found in the dry zone areas such as the North Central, Eastern, and North Western Provinces. These regions rely heavily on groundwater for drinking, making their populations particularly vulnerable to excessive fluoride exposure. As a result, a higher prevalence of dental fluorosis has been reported among children in these areas, particularly in

rural communities where access to treated water is limited. The condition is often linked to the consumption of groundwater with fluoride levels exceeding the WHO recommended limit of 1.5 mg/L [9].

DF is a growing public health concern in Sri Lanka, particularly in regions where groundwater fluoride concentrations exceed the recommended threshold of 1.5 mg/L [10]. Several studies have reported a high prevalence of DF among school-aged children, especially in the dry zone. In Kurunegala, 52% of 15-year-olds exhibited signs of fluorosis, while in Vavuniya, the prevalence was as high as 72.9% among children exposed to water containing an average of 1.58 mg/L fluoride [10]. A comparative study across four schools showed DF rates ranging from 51% to 78% in endemic areas, contrasting sharply with just 5.4% in non-endemic zones. In certain high-exposure communities, where water fluoride levels reached up to 9.8 mg/L, nearly 97% of children aged 12–14 were affected, with about 20% displaying moderate to severe forms. These findings indicate a strong correlation between groundwater fluoride levels and the prevalence and severity of dental fluorosis among children in Sri Lanka [11].

The primary determinants of dental fluorosis (DF) are the quantity and timing of fluoride intake, particularly during the critical period of tooth development. While ingestion of fluoride through drinking groundwater with high fluoride concentrations is a major risk factor, several other sources also contribute including the use of fluoride supplements, fluoride-containing toothpaste (especially when swallowed habitually), and infant formulas made with fluoridated water. In addition to these, various modifiable and non-modifiable factors have been identified in previous studies, such as age, gender, ethnicity, household income, parental education level, and child feeding practices [12].

Although DF is not classified as an oral disease, it can significantly affect an individual's physical, psychological, and social well-being. Among these, the psychological and social impacts are often more profound than the physical effects. For example, adolescents in Kibosho with visible signs of DF reported feelings of embarrassment about their appearance and tended to hide their smiles due to the condition of their teeth [13]. As DF is a preventable condition, increasing public awareness and knowledge particularly among parents and caregivers plays a crucial role in preventing its onset and reducing its long-term impact.

Previous epidemiological studies have demonstrated a high prevalence of DF among children and adolescents in these areas, with rates ranging from 43% to over 90% in certain endemic communities. The severity of DF correlates strongly with the level and duration of fluoride exposure during early childhood. Children under the age of eight are most vulnerable to fluorosis, as enamel formation occurs primarily during this period [14].

Despite this, awareness and understanding of DF among parents and caregivers remain limited, especially in rural communities relying heavily on untreated groundwater. Low parental awareness impedes early detection, prevention, and appropriate management, thereby exacerbating the psychosocial impact of DF, which has been

affected children's self-esteem and social interactions. Targeting parents of adolescents aged 12 to 14 years is strategic, as permanent dentition is generally fully erupted by this age, allowing for reliable clinical assessment of fluorosis and enabling parents to recognise its signs and seek timely intervention. This study focuses on the Dimbulagala zonal education area within the Polonnaruwa District an identified high-risk rural dry zone with documented elevated groundwater fluoride levels and significant DF prevalence [11].

Therefore, this study assessed the level of awareness about DF and its associated factors among parents of school children in Dimbulagala Educational zone. Assessing parental knowledge and awareness in this context is crucial for developing targeted educational interventions, improving community based preventive strategies to reduce the burden of DF in vulnerable populations. By addressing this knowledge gap, the study aims to contribute to better oral health outcomes and enhance quality of life for affected children and adolescents.

Methods

A descriptive cross-sectional study was conducted to assess parental awareness of dental fluorosis among school children aged 12–14 years in the Dimbulagala Educational zone. The study was carried out in three selected schools, each representing one of the three divisions in the zone: Maguldamana Maha Vidyalaya (Dimbulagala Division), Aselapura Maha Vidyalaya (Welikanda Division), and Alawakumbura Maha Vidyalaya (Aralaganwila Division).

The study population consisted of parents of students aged 12–14 years attending the selected schools. A multi-stage cluster sampling technique was employed. First, the three divisions were considered as separate clusters. From one division, one school type (there are 4 types of schools in Dimbulgala Educational Division. Type 1 – below 200 students, Type 2 - between 201-500 students, Type 3 – between 501-1000 students and Type 4 above 1000 students) was randomly selected as sub-cluster and one school was randomly selected as another sub-cluster from among the Type 2 schools in the zone. Same method was used to all three divisions. In each selected school, 91 students were randomly chosen (students from grades 7, 8, and 9), and their parents were invited to participate in the study. Participants included in the study were parents of male and female students aged between 12 and 14 years. Only those parents who were able to speak and write in either Sinhala or English were considered eligible. Additionally, participants were required to have been permanent residents of the Dimbulagala division for more than five years to ensure adequate exposure to local environmental conditions. The minimum required sample size was calculated using the standard formula proposed by Lwanga and Lemeshow [15], resulting in a required sample size of 273 participants.

$$n=\frac{z^2P(1-P)}{d^2}$$

n- Required sample size

z- The z value for the desired confidence level (95%)

P- Estimation of population percentage (80 %) [11]

d- Absolute error or precision

z=1.96, d=5%

Data were collected using a pre-tested, self-administered questionnaire developed by the investigators based on previous literature. The questionnaire was pre-tested among 30 parents from Manampitiya Sinhala Maha Vidyalaya, and several questions were modified for clarity based on their feedback.

Awareness was measured by using 11 questions regarding the DF. All the correct answers were marked and proportions of the correct answers were considered. The level of awareness was categorised into two categories as adequate awareness (>50% of the marks) and poor awareness (<50% of the marks).

Parents were provided with a detailed explanation of the purpose of the study and procedures through an information sheet, sent via their children, and informed written consent of the parents was obtained before recruitment of them. The questionnaire was sent to them through their children, and receipt of the questionnaire was confirmed via a follow-up telephone call. Participant's anonymity and confidentiality were maintained throughout the study and dissemination of findings.

Data were analysed using SPSS version 26.0. Descriptive statistics, including means, medians, frequencies, and percentages, were used to summarise data. Results were presented using bar charts, pie charts, histograms, and tables. Chi-square test was used to determine associations between variables and to identify group differences where appropriate. A *p*-value of less than 0.05 was considered statistically significant.

Results

Demographic characteristics of the participants

Among 273 parents of the students, the mean±SD age was 39.5±5.8 years. Table 01 shows the socio-demographic characteristics of parents. A greater proportion of the parents were female (n=154, 56.4%) and 98% were residing in rural areas. Among them 46.5% of the parents engaged in farming as the occupation and 56.8% (n=155) of them had less than 20000.00 LKR of monthly income.

Awareness of the parents about Dental Fluorosis

Majority of parents (n=227, 83.2%) demonstrated poor awareness regarding DF with only 16.8% had adequate awareness of the condition. Notably, 70.7% of the parents were unaware of the term DF itself. Table 02 shows the frequency distribution about awareness of DF among parents of school children in Dimbulagala Education zone. There were 158 participants (57.9%) who had known that their children were having mottled teeth and 60 (22%) of them had taken treatments for that condition. A considerable number of people thought that tooth forming age (n=68, 24.9%) and infancy (n=66, 24.2%) were the most vulnerable age groups for developing DF. Majority of the parents (n=230, 84.2%) were not aware that fluoride was the main factor of DF whereas 44.7% were not aware of the water sources in which has high fluoride

concentration. Of the sample, 49 participants (17.9%) thought that the ground water was having a high fluoride content.

The majority of the parents (n=237, 86.8%) were not aware that their water sources contain fluoride and also 60.8% did not know that their toothpaste contain fluoride as an additive. When consider awareness of the impact of DF, 48% of participants had wrong understanding on the matter that DF impact on maintenance of oral hygiene. The majority of the parents (84.25%) did not aware that fluoride is the main factor of causing DF.

Table 1 Socio-demographic characteristics of the parents (n=273)

Socio-demographic characteristics		**Frequency**	**Percentage (%)**
Parent's gender	Male	119	43.6
	Female	154	56.4
Occupation	Employed in government sector	49	17.9
	Employed in private sector	33	12.1
	Farming	127	46.5
	Engaged in trade	10	3.7
	Unemployed	40	14.7
	Other	14	5.1
Monthly income (LKR)	<20000	155	56.8
	20000 - 40000	75	27.5
	40000 - 60000	24	8.8
	>60000	19	7.0
Living area	Rural	267	97.8
	Urban	6	2.2

Concerning the awareness of parents about dental hygienic practices of their children, just over half of the parents (n=169, 61.9%) did not know whether their children are using fluoride contained tooth paste or non-fluoride toothpaste. Nearly 37% were using fluoride toothpaste while 1.5% were using non-fluoride toothpastes. Most of the parents (74%) knew that their children were using pea sized toothpaste for tooth brushing (Table 03).

Table 02 Awareness of Dental Fluorosis among parents (n=273)

Questions	Responses	No. of participants	Percentage (%)
How do you know about dental fluorosis?	From television	19	7.0
	From dentist	38	13.9
	From teacher	15	5.5
	From parents	8	2.9
	Not aware	193	70.7
Does your child has molted teeth?	Yes	158	57.9
	No	109	39.9
	Not known	6	2.2
Do you take a treatment for that condition?	Yes	60	22.0
	No	213	78.0
Which age category is/are high risk for dental fluorosis?	Infant age	66	24.2
	Tooth forming age in child	68	24.9
	Adolescents	33	12.1
	Younger age	16	5.9
	Adult age	14	5.1
	Old age	76	27.8
	No idea	0	0.0
Do you aware that fluoride is the main factor of dental fluorosis?	Yes	43	15.8
	No	230	84.2
Which water source/s have high fluoride concentration?	Ground water	49	17.9
	Lake water	26	9.5
	Tap water	29	10.6
	Filtered water	15	5.5
	Bottled water	2	0.7
	Boiled water	30	11.0
	Not known	122	44.7
Does fluoride is in your drinking water?	Yes	36	13.2
	No	237	86.8
Does fluoride is in your toothpaste?	Yes	107	39.2
	No	166	60.8

Which food/s contain in fluoride?	Tea	86	31.5
	Coffee	14	5.1
	Grapes	4	1.5
	Cow's milk	29	10.6
	Cola & soda drinks	75	27.5
	No idea	65	23.8
What is/are the impact of dental fluorosis?	Esthetic impact	44	16.1
	Impact of emotional stability	21	7.7
	Impact of oral hygiene maintenance	131	48.0
	Impact of speaking	6	2.2
	Impact of work	4	1.5
	No idea	67	24.5

Table 4 shows the parental awareness of dietary habits and drinking water hygienic habits. Approximately 44.7% of participants reported using filtered water for drinking purposes, while 36.6% relied on well water and 7.3% obtained their drinking water from lakes. Most of the parents (82.1%) concerned the quality of their drinking water and 47.3% had used water from wells for cooking. Nearly, 52% of children were given tea since early age and 89% did not drink tea often.

Association between socio-demographic factors and awareness of the DF

As indicated in the Table 5, there was no statistically significant associations between socio-demographic characteristics of the parents such as gender, monthly income, and awareness of the DF. There was a statistically significant association between living area, parent's occupation and awareness of the DF.

Table 03 Parent's awareness of dental hygienic practices among children (n=273)

Question	Responses	Frequency	Percentage (%)
Does your child use fluoride containing toothpaste?	Yes	100	36.6
	No	4	1.5
	Not known	169	61.9
How much of toothpaste does your child use to brushing?	Pea sized	202	74.0
	Brushing surface of a tooth brush	66	24.2
	Not known	5	1.8

Table 04 Frequency distribution of drinking water hygienic practices (n=273)

		Frequency	Percentage (%)
Source of drinking water	Filtered water	122	44.7
	From well	100	36.6
	Tap water	26	9.5
	From lake	20	7.3
	Bottled water	5	1.8
Concern about the quality of drinking water	Yes	224	82.1
	No	49	17.9
Source of your water for cooking	From well	129	47.3
	Filtered water	65	23.8
	Tap water	47	17.2
	From lake	31	11.4
	Bottled water	1	0.4
Giving tea for the child since early age	Yes	142	52.0
	No	131	48.0
Child drink tea often	No	243	89.0
	Yes	30	11.0

Table 05 Association between socio-demographic factors and awareness of Dental Fluorosis among parents

Socio-demographic factors		Awareness of DF		*p*-value
		Adequate awareness (n)	Poor awareness (n)	
Gender	Male	20	99	0.560
	Female	26	128	
Monthly income	<20,000 (LKR)	13	142	0.254
	20000 - 40 000	20	55	
	40 000 - 60 000	08	16	
	>60 000	05	14	
Living area	Rural	42	225	0.008
	Urban	04	02	

Occupation	Employed in government	33	16	0.000
	Employed in private sector	03	30	
	Farming	07	120	
	Engaged in trade	01	09	
	Unemployed	01	39	
	Other	01	13	

Discussion

In this study sample, almost half of the parents were engaged in farming (46.5%), and a little over half (56.8%) reported a monthly household income of less than 20,000 LKR (~70 USD). These socio-economic characteristics are consistent with rural populations in Sri Lanka, particularly in dry-zone districts where agriculture remains the primary livelihood. Comparatively, a study conducted in Pakistan reported that approximately half of the families (51.3%) had a monthly income ranging from 15,000 to 30,000 Pakistani Rupees (approximately 150–300 USD) [16]. The observed difference in income levels may reflect broader economic disparities between the two countries, as Pakistan's per capita income is generally higher than that of Sri Lanka. This economic contrast may also influence health literacy and access to oral health information and services.

One of the key objectives of the present study was to assess parental awareness of dental fluorosis (DF), a preventable condition with significant aesthetic and psychosocial consequences. To date, there is limited published research in Sri Lanka exploring parental knowledge of DF, highlighting the significance of this study in addressing a notable gap in the literature. The current findings demonstrate that 70.7% of parents were aware of dental fluorosis, and 57.9% recognised that their children had signs of mottled teeth. These findings indicate a relatively higher level of awareness when compared with a similar study in Pakistan, where 62.8% of parents were unsure whether their child had mottled teeth, and 84.8% were unsure of the broader societal impact of dental fluorosis [16]. Furthermore, only 13% of parents in the Pakistani study had heard of fluorosis, mostly through informal sources such as family, friends, or television.

The results of the current study also reflect positive oral hygiene practices among children. Nearly all participants (99.6%) reported using toothpaste, and the majority of school children brushed their teeth twice daily. These findings are in line with those reported by Sami (2016), [17] where 93% of children in Pakistan used a toothbrush and toothpaste, although brushing frequency was lower, with most children brushing only once daily. The similarities in toothpaste usage across studies suggest a generally good level of access to basic oral hygiene products, even in rural settings.

The study conducted in Thailand revealed that 50.5% of the parents knew the cause of DF and 40.7% of the parents acknowledge the prevention of this condition. Furthermore, 41.8% knew the treatment method while 30.5% recognised the relationship between DF and consuming over

standard fluoride drinking water. According to this study 78% of parents were not aware about the treatment of DF [18].

Despite relatively high awareness regarding the good oral hygiene practices, there are still gaps in knowledge regarding the fluoride content in drinking water and toothpaste, as well as the potential systemic effects of excessive fluoride intake. This underscores the need for targeted health education programs, especially in fluoride-endemic rural areas. Public health interventions should focus not only on improving awareness but also on promoting safe water practices, the use of low-fluoride toothpaste for children, and timely recognition of early signs of fluorosis.

Conclusion

The findings of this study indicate that the majority of parents in the Dimbulagala Educational zone of the Polonnaruwa District has overall poor awareness of DF and it highlights a significant gap in parental awareness regarding DF, indicating an urgent need for targeted educational interventions. A significant proportion of parents were unaware that fluoride is the primary causative agent of DF and lacked knowledge about the presence of fluoride in commonly used sources such as drinking water and toothpaste. Moreover, the majority were unaware that their local water sources, particularly groundwater and lake water could contribute to the development of DF in children.

Although no statistically significant associations were found between DF awareness and socio-demographic factors such as age, gender, or monthly income, significant associations were observed with parental occupation and residential area. These findings suggest that rural residency and agricultural occupations may be linked to lower levels of awareness, likely due to limited access to health information and preventive services in these settings.

Given that DF is a preventable condition, these findings underscore the need for targeted awareness and educational interventions. It is recommended that future research to be conducted across all schools in the Dimbulagala Educational zone to gain a broader and more representative understanding of parental knowledge and awareness. School-based awareness programs should be developed for teachers and parents, promoting understanding of fluoride levels in water sources, the importance of filtered or fluoride-free drinking water, and the use of non-fluoridated toothpaste. Parents can be empowered to support community-based water purification initiatives and disseminate health information to others.

Awareness initiatives should also include education on fluoride-rich foods, the clinical manifestations of dental fluorosis (DF), and preventive strategies as part of a broader primary health care approach. Additionally, early identification of children with DF and providing timely treatment can contribute to improving their quality of life. To address the issue comprehensively, support from government agencies and community stakeholders is essential in mobilising resources and implementing safe water and fluoride mitigation programs in rural regions.

This study was limited to a sample size of 273 parents from three selected schools within the

Dimbulagala Educational zone and, therefore, findings may not be generalizable to the entire district or other regions. Further, the applicability of the findings to other demographic or occupational groups may be limited because the majority of participants were farmers with low socioeconomic status. Future research involving larger and more diverse populations is recommended to draw broader and more representative conclusions.

List of abbreviations

DF- Dental Fluorosis

SPSS- Statistical Package for Social Sciences

WHO – World Health Organization

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Ethical considerations

Ethical approval was obtained from the Ethics Review Committee, Faculty of Allied Health Sciences, University of Ruhuna (Ref No.156.11.2022). Institutional approvals were also obtained from the Dimbulagala Zonal Education Office and the principals of the selected schools.

Declaration of conflicting interest

The authors declare that they have no competing interests.

Author contributions

All authors involved in conception of the study and design of the work. TP involved in data collection, analysed the data and initially draft the manuscript. HD and IK involved in reviewing of the manuscript. IK contributed for critically reviewing the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

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Systematic Review and Meta-analysis

Epidemiology, Risk Factors, Health Literacy and Emerging Diagnostic Approaches of Breast Cancer in Sri Lanka: A Systematic Review

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Abstract

A thorough grasp of epidemiology and screening techniques is required due to the increasing incidence of breast cancer in Sri Lanka. This review aims to study breast cancer epidemiology, health literacy and screening methods in Sri Lanka. A systematic search was conducted in Medline, Embase, PUBMED, and AMED databases with studies conducted in Sri Lanka up to 2024. Two independent researchers identified 149 studies, from which data were extracted from 27 eligible studies by the PRISMA guidelines. The quality of the studies was evaluated using the quality assessment tools in the National Institute of Health. The available epidemiological data on breast cancer in Sri Lanka are limited. Contributing factors to the high mortality rate include low health literacy, barriers to care, and delays in diagnosis and treatment. The awareness about breast cancer is low, especially regarding diagnosis and breast self-examination (BSE). The practice of BSE is rare. Health education appears to improve health literacy. Notable breast cancer risk factors are menopause, abortions, passive smoking, age (>45), early menarche (<12 years), late menopause (>55 years), no children, oral contraceptives, alcohol and tobacco use, diabetes, family history, radiation, obesity, and prolonged breastfeeding. The screening and diagnosis tests are mammography, breast self-examination, clinical breast examination, molecular detection, and histology. The limited resources allocated for screening and diagnostic services in Sri Lanka present a significant challenge for early detection and management of diseases. The future paths for the diagnosis are considering genetic variations with advanced molecular methods. Considering the high incidence and limited awareness, the adoption of highly accurate screening and diagnosis techniques, with nationally accessible educational programs about breast cancer awareness is necessary.

***Keywords**: Breast cancer, Epidemiology, Health literacy, Screening, Diagnosis*

Introduction

Breast cancer stands as a formidable global health challenge, affecting millions of women and, to a lesser extent, men [1-7]. Women are a risk of developing breast cancer at any age after puberty, and the risk increases with age [7]. In most nations, this disease pattern is common.

Breast cancers are an expansion of the epithelial cells that line the glandular tissue of the lobules (15%) or ducts (85%) of the breast. In situ refers to the initial confinement of the malignant development to the duct or lobule and usually presents with no symptoms and minor metastasis changes. Yet, over time, these in situ (stage 0) tumors may develop into regional metastasis (invade neighboring lymph nodes) or may develop into distant metastasis as invasive breast cancer (invade the breast tissue around). Extensive metastasis is the frequent cause of death due to the breast cancers in women [4,7].

The disease of breast cancer is not contagious. There are no known viral or bacterial infections linked to the development of breast cancer, in contrast to several cancers that have infection-related origins, such as human papilloma virus infection and cervical cancer [7].

Worldwide, 1.5 million women, or about 25% of all cancer patients, receive a breast cancer diagnosis each year [2,5]. Globally, 2.3 million women had a breast cancer diagnosis in 2020, and 685,000 deaths were attributed to the disease. Among Asian women, breast cancer is the most common cancer. In 2017, a huge number of new cases has been reported among women [6]. Male breast cancer accounts for approximately 0.5% to 1% of all breast cancer cases worldwide. Despite the biological and clinical differences, men are generally diagnosed, treated, and managed same as female breast cancer patients. [7].

A thorough grasp of the epidemiology of the diseases and screening methods within Sri Lanka, a country in central Asia, is desperately needed as the country struggles with an increasing number of breast cancer cases [1, 8-11]. Over time, breast cancer has become more common in Sri Lanka. Data from the National Cancer Registry reveals a doubling of breast cancer cases from 4.6 per 100,000 women in 1985 to 9.8 in 2005, highlighting a substantial and alarming increase. This surge in cases poses a significant public health challenge and also underscores the urgency of understanding the underlying factors contributing to this trend. Previous studies provide glimpses into the prevalence landscape; nevertheless, a systematic review is warranted to synthesise and critically appraise the existing literature, identifying gaps and opportunities for further exploration [1,8].

More than half of the women diagnosed with breast cancer had no known risk factors for the disease, except for age and female gender [1,7]. Some important known risk factors for breast cancer include aging (over 40), obesity, alcohol consumption, family history, reproductive history, including the age of the first pregnancy and menstruation, radiation exposure, tobacco use, and postmenopausal hormone therapy [1,7]. The female gender is considered the major risk factor [1,7]. Early detection remains a cornerstone in mitigating the impact of breast cancer [12,13]. In Sri Lanka, however, challenges in access to care,

knowledge gaps, and delays in screening, diagnosis, and treatment have contributed to a relatively low survival rate [9,14-17]. Understanding the efficacy of existing strategies and potential barriers to their implementation is pivotal in designing targeted interventions that can enhance early detection rates and, subsequently, survival outcomes.

The role of health literacy in breast cancer awareness, prevention, and early detection cannot be overstated. According to some previous studies, Sri Lanka grapples with disparities in health literacy, which can impact the effectiveness of screening programs and overall disease understanding [9,14-17]. Worldwide, mammography, breast MRI, and breast self-examination are recommended breast cancer screening methods. Although breast cancer is the most common cancer in Sri Lanka, limited resources prevent a nationwide mammography program. Mammography is available in 18 public hospitals and some private facilities, but breast self-examination is promoted as an alternative [18-20]. Globally, advanced diagnostic techniques such as MRI, flow cytometry, ultrasound, RT-qPCR, and hybridization methods are used, but molecular diagnostics in Sri Lanka are largely limited to the Medical Research Institute [18-20].

This systematic review explores breast cancer in Sri Lanka, focusing on its prevalence, risk factors, and the effectiveness of current screening and diagnostic methods. By comparing local practices with global standards, the review aims to inform public health strategies and improve early detection and outcomes for the readers. A key component is assessing community health literacy on breast cancer. By identifying knowledge gaps, future researchers can develop targeted educational initiatives that empower individuals to make informed decisions, reduce risk, and better navigate healthcare systems through improved awareness and understanding of prevention and early detection.

Methods

The protocol for the current systematic review, considering the study design, was registered on September 22, 2022, in the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42022359600). The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) protocol served as the basis for the methodology of the current systematic review (Figure 01) [1, 21].

Any studies published in English were considered. All the full paper articles that assessed breast cancer diagnosis conditions in adult humans that were conducted only in Sri Lanka were eligible to be included in the review. Studies that were in other languages, not conducted in Sri Lanka, were excluded. Conference papers, review papers, commentaries, research notes, reports, or editorials were also excluded. The systematic review was conducted at the Department of Medical Laboratory Science, Faculty of Allied Health Sciences, University of Peradeniya.

Data up to 2024 were searched using Medline, Embase, Google Scholar, PUBMED, and AMED databases. The search strategy used key terms related to breast cancer in Sri Lanka: epidemiology, health literacy, screening, diagnosis, and risk factors.

Studies assessing epidemiological data (prevalence, incidence, mortality rates, and survival rates) of breast cancer in Sri Lanka were extracted. Potential risk factors for breast cancer, screening, and diagnosis methods, and the level of health literacy of the community about breast cancer in Sri Lanka were also eligible for the final inclusion. Future directions regarding study on breast cancer were also noted. Two reviewers separately extracted the data and inspected the whole text, abstract, and titles. A third reviewer was involved if there were any disagreements.

The data were extracted directly into the COVIDENCE software and then exported into an Excel sheet for further analysis. The publication details (Supplementary Materials; Table 01), the data regarding the people with breast cancer, and details about the outcomes were extracted. Data were narratively synthesised, and the findings were tabulated and graphically summarised to address the research objectives appropriately.

The epidemiology of breast cancers in Sri Lanka, including their prevalence, incidence, mortality, and survival rates, was the primary outcome measure. Any quantitative and qualitative outcome measures were used to measure outcomes. As the secondary outcome measures, potential risk factors for breast cancer, screening, and diagnosis methods, and the level of health literacy of the community about breast cancer in Sri Lanka, including patients, healthcare workers, and school children, were assessed. Any quantitative and qualitative outcome measures were used to measure secondary outcomes.

The quality of the included studies was evaluated using quality assessment tools for observational cohort and cross-sectional studies, controlled intervention studies, systematic review and meta-analysis, and case-control studies in the National Heart, Lung and Blood Institute [22]. Although not all quality assessment criteria were fully met, all 27 studies were included due to the limited number of articles available in Sri Lanka, particularly on breast cancer epidemiology.

Results

A total of 149 citations were found in the preliminary literature search. The duplicates were removed, and the inclusion and exclusion criteria were applied. Of these, 27 studies were found to need additional examination (Figure 01).

When considering the quality of the studies included in the review, almost all studies have clearly stated the research questions or objectives. Predetermined inclusion and exclusion criteria were not reported in over half of the investigations. The exposure and outcome measurements in the majority of the research were well-defined, legitimate, and trustworthy. However, the majority of studies did not report the sample size rationale. The following criteria did not apply in most studies: follow-up after baseline ≤20%, adjustment for potential confounding variables, adequate time frame, exposure(s) of interest measured before the outcome(s), exposure(s) measured more than once over time, and outcome assessors blinded to the exposure status (Supplementary materials -Figure 01).

Epidemiology of breast cancer in Sri Lanka

There were only 10 studies that provided information on epidemiology (Table 01). However, it lacked some necessary information,

particularly about the prevalence, mortality, and morbidity rates of breast cancer in Sri Lanka.

In one study on breast cancer in Sri Lanka, two-thirds of patients were diagnosed at stages I and II at the time of diagnosis. Approximately 72% of patients tested positive for estrogen receptor (ER)/progesterone receptor (PR), while 22% tested positive for human epidermal growth factor receptor 2 (HER-2) [11, 19, 23-25]. Fifty-three (24%) of the tumors were triple-negative [19]. Diabetes mellitus and hypertension were common co-morbidities [11]. The incidence of female breast cancer in Sri Lanka has risen from 17.3 per 100,000 in 2001 to 24.7 per 100,000 in 2010. This increase has been steady but considerable [8]. Furthermore, the age group of 75 and older had the highest incidence of male breast cancer (3.38 per 100,000 people) [8]. In the included studies, the survival rates were around 70-90% (acceptable 5-year survival rates without breast cancer). Patients with localised cancer had a 1.6% median overall survival rate, whereas patients with metastatic disease had a 30-month median survival rate [17, 20, 26, 27]. The mortality rate was 9% [20].

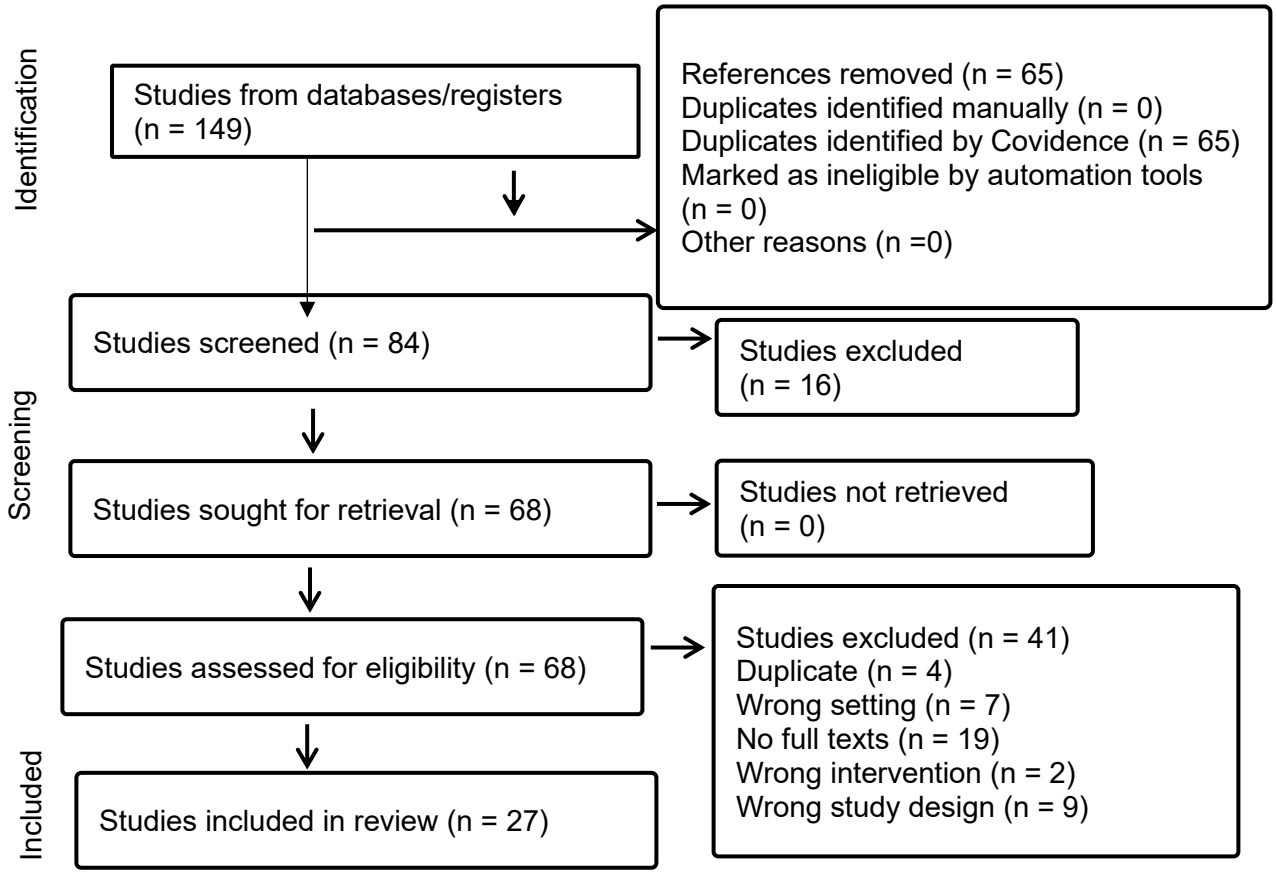

Figure 01: Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram.

Sri Lankan health literacy concerning breast cancer

Nine studies offered health literacy related to breast cancer in Sri Lanka (Table 01).

Inadequate health information about breast cancer was found in eight of the nine investigations, especially about diagnosis and breast self-examination (BSE) [14, 15, 18, 28-33]. Women's awareness was marginally higher than men's [15]. Effective health education programs have been shown to raise health literacy in the population [18, 32, 33]. Even though health literacy is higher in one study, participants' clinical breast inspection and self-examination practices are very poor [32].

Table 01 Main findings of epidemiology, health literacy, risk factors, screening, diagnosis, and future directions of breast cancer in Sri Lanka

No. of participants	Sex	Mean age (years)	Outcome	Sources
>2000	Female	52	The acceptable 5-year survival rate is 71% breast cancer.	[17]
73		34.5	In the BRCA2 hotspot locations, the prevalence of pathogenic and potentially pathogenic mutations was 6.3% and 23%, respectively.	[23]
19,755	98% were females and 2% were males.	53.1	The percentage of female breast cancer in Sri Lanka has gradually increased (17.3 per 100,000 in 2001 (95% confidence interval (CI) to 24.7 per 100,000 in 2010 (95% CI).	[8]
713	Female	NI	Recurrence-free survival (RFS) was Low-risk (LR) -85%, intermediate-risk (IR) -84%, and high-risk (HR) -65%, and five-year breast cancer-specific survival was LR-100%, IR-91%, HR-66%.	[26]
944	Female	NI	The breast cancer-specific survival after five years = 78.8%.	[27]
233	Female	55	94% of malignancies are ductal carcinoma.	[24]
124	Female	NI	Global studies indicate that the rates of ER, PR, and Her/2neu amplification in breast cancer were comparable among Sri Lankans.	[25]

5181	Female	56	At the time of diagnosis, two-thirds (66%) of the malignancies were in stages I and II.	[11]
221	Female	56.25	Fifty-three (24%) of the overall tumors were triple-negative (95% CI=18.37%–29.63%).	[19]
208	Female	56.39	19 (9%) People died, leaving 174 (82.9%) disease-free. With metastases, 13 (6.2%) and 4 (1.9%) of the survivors experienced recurrences.	[20]
865	Female	55.5	Insufficient understanding and knowledge about breast cancer (odds ratio 1.7; 95% confidence interval 1.1-2.7)	[28]
			Poor knowledge	[29]
400	Female	27-76	Insufficient knowledge about diseases, treatments, diagnosis, and physical screenings, particularly among younger (age ≤37) and more educated (p<0.0001) women.	[30]
1500	Male-725 Female-775	37.21	Inadequate health literacy for early detection and screening (screening and early diagnosis).	[31]
219	Female	<35=104 (47.5) 35-45=48 (21.9) 46-55= 50 (22.8) >55=17(7.8)	More than 98% were aware of breast self-exams. 84.1% of people practiced it, although only 47.9% did so every month. Of those surveyed, 94.1% were aware of clinical breast exams and 64.3% were aware of mammograms, while 94.1% were aware of clinical breast exams. Of them, 19.2% had had a clinical breast examination within the previous year, and 3.6% had ever had one.	[32]
859	Female	NI	Inadequate knowledge of health. (In particular, inadequate understanding of breast self-examination). Out of the entire sample, 17.1% were able to self-examine their breasts.	[14]
260	Female	43	Inadequate literacy before the intervention in health education.	[33]
38- Intervention Group (IG) 47-Control Group (CG)	Female (Public Health Midwives)	IG- 42.5 CG- 43.0	Inadequate reading comprehension before the health education program.	[18]

282 (n-282, 564 individuals) couples	Male and female-775	Females: 43.05 Males: 44.83	Both sexes had a low level of health literacy for all cancers. Women's awareness was marginally higher than men's.	[15]
100	Female	36-64	Menopause and abortion, and passive smoking.	[1]
944	Female	NI	Premenopausal status, big tumors with positive lymph nodes, and a family history of breast cancer	[27]
859	Female	NI	Greater age (>45), early menarche (<12 years), late menopause (>55 years), no children, more than five children, late age at first childbirth, radiation, breastfeeding, alcohol, tobacco, diabetes, prior history of breast lumps, oral contraceptive, and a positive family history	[14]
700	Female	cases -60 controls -74	Common postmenopausal Sri Lankan women.	[12]
260	Female	43	Obesity, long-term use of hormone replacement therapy or oral contraceptives, early menarche, late menopause, not having children, genetic, first pregnancy beyond 30 years, breast cancer in the past or family history, extended breastfeeding, and having more children	[33]
38	Female	IG- 42.5 CG- 43.0	Obesity, long-term use of oral contraceptives or hormone replacement therapy, early menarche, late menopause, nulliparous women, first pregnancy beyond age 30, ovarian cancer in the family, and a history of breast cancer in the past.	[18]
NI	NI	NI	Screening test- Clinically and Histologically (mammographic screening, breast self-examination, clinical breast examination. Diagnostic test- Histology and Molecular diagnosis	[33]
742	Female	NI	Screening test- Clinically and Histologically. Diagnostic test- Histology-It is a simple and	[34]

			inexpensive tool in the prognostication of breast cancers.	
130	Male and Female	Familial breast cancer patients-46.97, Sporadic breast cancer patients-47.37, risk Individuals-40.51	In disease, the BRCA1 gene has nineteen sequencing variations identified. In diagnosis, Single conformation analysis and hetero-duplex analysis were used to screen exon 11. Sequencing was done on polymerase chain reaction (PCR) products that displayed aberrant patterns in SSCP. The 11th exon was sequenced directly.	[35]
48	Female	NI	In diagnosis, thirty-one variations demonstrated genome-wide suggestive heterogeneity, logarithm of odds. While linkage studies have been used to identify variants linked to cancer worldwide, little is known about their role in non-BRCA1/2 persons in Sri Lanka.	[36]
149	NI	familial breast cancer patients-47.76±9.55 sporadic breast cancer patients-47.60±10.49	In disease, when compared to earlier findings for the BRCA1 gene, Sri Lankan family breast cancer patients had higher frequencies of pathogenic and potentially pathogenic mutations in the BRCA2 gene. In diagnosis, direct sequencing (exon 11) and sequencing of aberrant bands following screening with single-strand conformation polymorphism (remaining exons).	[37]
73	NI	34.5	In the disease, thirty-six sequence variants were found. It consists of two intronic variants of unknown relevance, two variants of questionable significance, seven pathogenic and two likely pathogenic variants, and 23 benign variants.	[23]
105	NI	47.76 ± 9.55 -familial breast cancer patients	In the disease, an unclear loss was found in exon 6 of the BRCA1 gene in one patient with familial breast cancer. The unclear region's whole sequencing was used to diagnose multiplex ligation-	[38]

			dependent probe amplification and to validate MLPA results.	
865	Female	55.5	In the disease, only 34 patients with occult metastasis	[28]
92	Male and Female	patient cohort- 59.24 Breast Cancer- 60.29, Colorectal cancer- 48.9, healthy female controls, and healthy male controls- 49.01	In disease, twenty-seven sequence variants were discovered, several of which were unique in the TP53 gene. In diagnosis, PCR and direct sequencing are used to determine the TP53 mutant status.	[39]

NI-Not Indicated

Risk factors of breast cancer in Sri Lanka

In Sri Lanka, risk factors include menopausal, abortions, passive smoking, age above 45, having early menarche (before the age of 12), late menopause (beyond the age of 55), no children, more than five children, oral contraceptive, alcohol and tobacco use, diabetes, prior history of breast lumps, family history of breast cancer, radiation, obesity, prolonged breastfeeding, and first pregnancies after age 30 [1, 12, 14, 18, 27, 33].

Screening and diagnostic methods of breast cancer in Sri Lanka

Mammography screening, breast self-examination, and clinical breast examination are examples of screening tests that are performed both clinically and histologically. Histology and molecular diagnosis are confirmatory tests which considered diagnostic methods. Histo-pathological diagnosis has aided in the precise Molecular diagnosis of complex malignancies, which is crucial for the choice of the most suitable course of treatment [29, 34].

Future directions of research related to breast cancer in Sri Lanka

Future directions for the diagnosis of breast cancer will be more towards advanced molecular techniques [35-39]. Examples include the use of multiplex ligation-dependent probe amplification (MLPA), single-strand conformation analysis (SSCP), hetero-duplex analysis, PCR, direct sequencing (exon 11), and sequencing of aberrant bands following screening with single-strand conformation polymorphism (remaining exons) [23, 35-39]

Discussion

The current systematic review addresses the epidemiology, health literacy, risk factors, screening and diagnostic methods, and future research directions for breast cancer in Sri Lanka. This is the most common cancer in Sri Lanka [1, 8, 9]. However, there is a lack of comprehensive epidemiological data with the above other details in Sri Lanka. The current study also faced limitations in obtaining specific data on prevalence, mortality, and morbidity rates.

In terms of epidemiology, our research revealed that there are a few details on the prevalence of ER and PR positivity, which are consistent with previous studies [11, 16, 17, 19, 25]. Additionally, triple-negative tumors accounted for 24% of all cancers in this study [19]. Despite limited published articles, it is evident that breast cancer prevalence is significant in Sri Lanka, particularly among females, according to the epidemiological data of the country [10]. Compared to most populations investigated in West and East Asia, the prevalence of breast cancer is higher in Sri Lanka [18-20].

It is predicted that among elderly women, the incidence of breast cancer will increase. This is common, especially those who are also more likely to have co-morbidities with diabetes mellitus or hypertension, and a worse probability of surviving breast cancer [6]. Sri Lanka shows an increase in the incidence of female breast cancer, demonstrating a steady but significant rise [8, 10]. This sharp increase in cases has raised severe public health concerns [1, 11]. In contrast, the incidence among men has remained relatively stable [8]. In line with other countries, our research revealed that the age range of 75 and above has the highest prevalence of male breast cancer. Breast cancer is a rare condition in the male population (around 0.5–1%). The reason for the low incidence is its comparatively small quantity of breast tissue in men, and the differences in their hormonal milieu account for the low incidence rate. Men have less breast tissue than women do, but the elements that affect malignant alterations are similar [18-20].

The breast cancer survival rate was very low in Sri Lanka [9, 14-17, 20, 26, 27]. Nevertheless, in other countries, current findings regarding survival rates are different. For instance, in the United States, women have high survival rates. When considering the relative survival rate from breast cancer, compared to white women, black women had a 9% lower level [18-20]. It indicates that, in Sri Lanka, the survival rate for breast cancer is also relatively low due to several factors, such as a lack of knowledge about the disease, a lack of cancer-related literacy, a lack of access to care, and a delay in diagnosis and treatment [9, 14-17]. The reported death rate of breast cancer is 9% in the included studies[20]. This rate is 2.5% globally [18-20]. Hence, the death rate is also high in Sri Lanka.

The current study discovered a lack of health awareness regarding breast cancer, primarily about diagnosis and BSE [14, 15, 18, 28-33]. Results of health literacy are similar to those in some nations, for example, a more extensive study conducted in Northern Saudi Arabia likewise revealed low general awareness of BSE and breast cancer [18-20]. The current study shows that men and women had slightly different levels of awareness (slightly lower levels in men) [15]. Regrettably, other countries also experience the same situation [18-20]. In communities where males dominate gender roles, more awareness of men may encourage women to use screening facilities. Thus, there is a mandatory awareness among men regarding female cancer. Despite higher health literacy, the clinical breast inspection and self-examination habits of the participants in this study are very rare [32]. Effective health education can raise health literacy, according to two studies [18,32,33]. Comparable outcomes have been reported in

previous literature regarding educational initiatives to improve BSE for medical professionals and women in communities throughout the Asia-Pacific area [18-20]. Nonetheless, research has indicated that higher general literacy rates have a positive impact on breast cancer prevention practices [18-20]. Therefore, it might also require appropriate training for students and the community (both males and females). Hiring well-trained public health nurses and midwives, the community's front-line healthcare providers, could be a solution, as the current study found that healthcare staff's awareness of BSE and breast cancer is also somewhat lacking [18]. Similarly, in other countries, the knowledge of health care providers, like midwives, is low regarding breast cancer prevention.

The risk factors for breast cancer identified in our study include menopause, abortions, exposure to secondhand smoke, age >45, early menarche (<12 years), late menopause (>55 years), having no children or more than five children, oral contraceptive, alcohol and active tobacco use, diabetes, history of breast lumps, family history of breast cancer, radiation exposure, obesity, prolonged breastfeeding, and first pregnancies after age 30 [1, 12, 14, 18, 27, 33]. Overall, the risk factors for breast cancer in other nations are the same [7, 14, 26]. Thus, any special risk factors were not found in Sri Lanka.

Guidelines for the early detection and referral of seven prevalent malignancies in Sri Lanka were recently published by the National Cancer Control Program [10]. The BSE, clinical breast examination, and mammography screening are a few examples of screening tests, and molecular diagnostics and histology are confirmatory diagnostic tests in our study. The accurate diagnosis of complicated cancers, which is essential for selecting the best course of treatment, has been made possible by molecular diagnosis [29,34]. Worldwide, mammography, breast magnetic resonance imaging, and breast self-examination are the recommended methods for screening for breast cancer [18-20]. Even though breast cancer is the most prevalent cancer in Sri Lanka, the government does not have the resources or personnel to launch a nationwide mammography screening program. Although 18 public hospitals and a few private sector facilities do mammography screening, breast self-examination is advised as a substitute [2, 10]. Numerous imaging and molecular biotechnology-based diagnostic techniques have been developed worldwide for definitive disease diagnosis. Such examples include magnetic resonance imaging (MRI), flow cytometers (FCM), mammography (MG), ultrasound (US), and real-time fluorescence quantitative PCR (RT-qPCR), protein hybridization (PHS), and nucleic acid hybridization (NAHS) [18-20]. Molecular diagnostics in Sri Lanka, however, is severely restricted to the Medical Research Institute (MRI), Sri Lanka [29]. Taking advantage of these positive features might also offer an opportunity to exert control over the handful of native healers who practice Ayurveda medicine and assert their ability to treat cancer [29].

The results of our study, along with those of several other studies, have indicated important avenues for future research in the areas of breast cancer and the discovery of related genetic variations. The greater frequency of pathogenic

and possibly pathogenic mutations in the BRCA2 gene among individuals with familial breast cancer from Sri Lanka is one of our study's most notable findings. This pattern deviates from earlier research that focused on a higher incidence of BRCA1 mutations, suggesting a potential genetic predisposition that is specific to a region or community [23, 35-39].

These results highlight the need for more thorough investigations and the creation of specialised treatment plans that are adapted to the distinct genetic characteristics seen in particular communities. It is anticipated that developments in molecular genetic technologies, which provide increased sensitivity and specificity in mutation identification, will propel the field of breast cancer diagnostics in the future. For example, methods like multiplex ligation-dependent probe amplification (MLPA) are essential for identifying significant genomic rearrangements that traditional sequencing might overlook. Furthermore, heteroduplex analysis and single-strand conformation polymorphism (SSCP) are useful techniques for screening mutations, especially when paired with polymerase chain reaction (PCR) amplification techniques to increase detection efficiency [23, 35-39].

Furthermore, a more thorough examination of the BRCA1 and BRCA2 genes is made possible by the direct sequencing of exon 11, an area known to contain common mutations, and the sequencing of abnormal bands discovered while screening the remaining exons using SSCP. These techniques make it possible to find both common and uncommon variations that could raise the chance of developing hereditary breast cancer [23,35-39].

When combined, these molecular techniques not only help detect breast cancer earlier and more precisely, but they also open the door to customised care, in which a patient's genetic composition informs therapy and surveillance plans. The incorporation of state-of-the-art diagnostic technologies will be crucial in enhancing clinical outcomes and directing public health initiatives as research continues to identify new variants and molecular pathways linked to breast cancer, especially in genetically diverse and underrepresented populations like those in Sri Lanka.

Conclusion

Though the published articles is less, the incidence, prevalence, low survival rate, and death rate are significant in our country, particularly among females. These are caused by several issues, including a lack of awareness about the illness both in the community and the healthcare system, illiteracy regarding cancer, difficulty accessing care, and a delay in diagnosis and treatment. The practice of BSE is rare. The risk factors among the Sri Lankan population are mainly menopause, abortions, passive smoking, age (>45), early menarche (<12 years), late menopause (>55 years), no children, oral contraceptives, alcohol and tobacco use, diabetes, family history, radiation, obesity, and prolonged breastfeeding. In Sri Lanka, the screening and diagnosis tests are mammography, breast self-examination, clinical breast examination, molecular detection, and histology. However, there is an issue with the

nation's limited resources for screening and diagnosis.

These findings underscore the urgent need for improved breast cancer awareness, early detection, and treatment strategies in Sri Lanka. Future research should focus on addressing the gaps in epidemiological data and exploring effective interventions to reduce the burden of breast cancer in the country. It can be observed that both health literacy and screening/diagnosis mechanisms need to be on par with the modern technology available in the world. It should be vital to establishing nationally accessible educational programs about breast cancer awareness among men and women.

Limitations

Lack of published articles, especially regarding the epidemiology of breast cancer, was the main limitation.

List of abbreviations

AMED databases - Allied and Complementary Medicine Database
EMBASE - Excerpta Medica data BASE
NIH - National Heart, Lung, and Blood Institute
BSE - Breast self-examination
PRISMA - Preferred Reporting Items for Systematic Reviews AND Meta-Analysis
MLPA - Multiplex Ligation-Dependent Probe Amplification
SSCP - Single-Strand Conformation Analysis
NI - Not indicated
CI - Confidence Interval
IG - Intervention Group
CG - Control Group
BC - Breast Cancer
CRC - Colorectal Cancer
RFS - Recurrence-free survival
LR - Low-Risk
IR - Intermediate-Risk
HR - High-risk
PCR - Polymerase Chain Reaction
ER - Estrogen Receptor
PR - Progesterone Receptor
HER-2 - Human Epidermal Growth Factor Receptor 2

Declaration of conflicting interest

The authors declare no conflict of interest.

Author contribution

Concept/design was done by WMHBS, WPASL, JKLTD and Data acquisition and analysis was done by WMHBSM, WPASL**.** Final Drafting and revision were done by WMHBSM, JKLTD.

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Brief Report

Harm Reduction in Controlling the Burden of Alcohol Use in Sri Lanka: Implications and Future Prospects

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Alcohol poses detrimental consequences to the user, and causes more harm to the society than the harm caused to the society by any other addictive substances used by the humans. [1-3]. Alcohol use is among the leading causes of disability and premature mortality worldwide [1]. World Health Organization (WHO) estimated that globally, 2.6 million deaths per year are attributable to alcohol consumption, accounting for 4.7% of all deaths [1, 2]. Heavy and hazardous alcohol consumption is associated with the development of liver diseases, cardiovascular diseases, cancers, and mental health disorders including suicide and deliberate self-harm [1]. Healthcare costs of treating these health conditions places a significant burden on healthcare budgets of those countries where alcohol is prevalent [2, 4]. Alcohol-related violence, property damage, accidents and family conflicts deter social harmony and incur huge costs for law enforcement and emergency response systems and for rehabilitative services [1, 4, 5]. A systematic review of alcohol use in high-income countries found that alcohol use costs an average of 2.6% of Gross Domestic Products (GDP) in those countries [4]. Thus, health, economic, social and environmental adverse effects of alcohol use are found to be a major threat for many countries to achieve several Sustainable Development Goals (SDGs) including poverty reduction, control of non-communicable diseases and gender equality [1, 3, 6].

Sri Lanka is a middle-income country in South Asia with a population of 21 million and a GDP per-capita of USD 3342 in 2022 [7]. In the year 2019, alcohol attributable deaths per 100,000 population were 24.0 for men and 3.4 for women in Sri Lanka [1].

A community-based research conducted in urban Sri Lanka indicated that about 9% of adults were unsafe alcohol users, and among unsafe alcohol users, the prevalence of alcoholic fatty liver was 31.6% [8].

The estimated total economic cost of alcohol in Sri Lanka in 2015 was USD 885.85 million which was 1.07% of the GDP in that year [5]. Although the cost of alcohol related violence, family conflicts, property damage, workplace dynamics and environmental consequences are huge in Sri Lanka, reliable estimates are not available. Alcohol use is predominantly a male habit in Sri Lanka [9, 10], and nowadays in major social events, parties and celebrations, alcohol is well presented. In disadvantaged communities, such as estate workers in the tea plantation sector in the country, an accepted culture of daily alcohol consumption is seen [11, 12]. It is observed that children of alcohol users are more likely to develop alcohol and other drug use behaviors due to a combination of genetic predisposition and learned behaviors [2, 10]. Growing up in a household or in an environment where alcohol use is prevalent may lead young children to digest drinking as a normal human behavior. The trend towards female-focused alcohol promotions is seen in the country in parallel to the rising trends of Sri Lankan women's socio-economic power [9, 11]. Westernization of the society and people's exposure to cultures where alcohol use is an acceptable social behavior, young children and women in Sri Lanka are at higher risk of becoming alcohol users in their middle and old ages. These trends indicate that alcohol use is a serious and uncontrollable growing public health issue in Sri Lanka.

Complete abstinence (sobriety) from alcohol consumption has been viewed as the most effective way to recover from alcohol use disorders [13-15]. It has been the primary outcome of many population health alcohol control programs across the world. However, current evidence suggests that control and recovery strategies that lessen heavy use of alcohol without complete abstinence are effective in reducing the harms associated with alcohol use behavior of current alcohol users [14-16]. Harm reduction of alcohol use focuses primarily on reducing harmful consequences associated with alcohol use, providing alternative to zero-tolerance approaches by incorporating drinking goals (abstinence or moderation) that are compatible with the needs of the individual, and promoting the user's access to treatment, counseling and preventive services [13-16].

Although sobriety is the safest course for certain population groups such as cardiovascular patients or pregnant women [1, 2, 17], harm reduction strategies that are non-abstinence based have become effective strategies to lower morbidity and mortality rates in alcohol users and to expedite the recovery process of alcohol users in the general public. Sobriety which was the eventual target of many alcohol prevention and control strategies in the past may not be realistic in the future due to drastic changes in social values and cultural changes in the substance use behavior in the Sri Lankan society [10-12]. Alcohol industry, tourist industry and import and export industry in the country are interlinked tightly so that significant changes in one industry would eventually affect the progress and growth of the other industries. Studies on alcohol use

have demonstrated that harm reduction approaches to alcohol problems are at least as effective as abstinence-oriented approaches at reducing alcohol consumption and alcohol-related consequences [14-16].

Harm reduction of alcohol use

To control the use of alcohol and associated negative consequences, reductions in the supply, the public demand and reductions in harmful and adverse consequences of alcohol use are needed to be fulfilled [1, 18]. In supply reduction, price increase, decrease the availability of illegal alcoholic beverages and decrease in social tolerability of alcohol use should be promoted [18-20]. Demand reduction of alcohol use comprised of actions to decrease the public desire for alcohol use by employing educational and behavioral interventions for risk populations and early identification of vulnerable groups and prevention and opening of treatments and rehabilitation services for problematic alcohol users [1, 18, 21]. Harm reduction of alcohol use is more pragmatic and realistic approach and it does not emphasis complete cessation of alcohol use [13, 15, 22]. It is observed that attempts that force abstinence on every alcohol user against their will generally end up with failures and actually leads to elevate harms caused by the user [15, 19]. Also, attempts made to eliminate all alcohol related harm by forcing alcohol users to practice moderate drinking will eventually lead to elevate alcohol related harms overall [14, 15]. Thus, the most effective control strategy is to motivate alcohol users to set their own alcohol control goals which can range from safer drinking to reduced drinking to quitting altogether [14, 16, 19]. Harm elimination can be done by those who seek to eliminate all harm by pursuing perfect moderation or perfect abstinence. In harm reduction of alcohol use, it is imperative to make attempts to reduce immediate major harms than eventual harms.

The primary aim of harm reduction of alcohol use is to minimise health, social, and economic risks of the use of alcohol. This can be achieved through alcohol control policies, programs, and practices without necessarily reducing the alcohol consumption [13, 15, 16]. Harm reduction of alcohol use embraces the inherent value of people and promotes equity, rights, and reparative social justice. Substance Abuse and Mental Health Services Administration (SAMHSA) in the US defined harm reduction of alcohol use as "*a practical and transformative approach that incorporates community driven public health strategies including prevention, risk reduction and health promotion to empower people who use alcohol and their families with the choice to live healthy, self-directed, and purpose filled lives"* [23]. Denis-Lalonde and colleagues (2019) describe the term harm reduction of alcohol use using seven attributes; reduction of harm rather than the reduction of alcohol use, alcohol users being the key stakeholders and participants in harm reduction program planning and delivery, promotion of alcohol user's right to be treated with dignity rather than as a criminal, promotion of health in communities and populations, treating alcohol use as a morally neutral behavior, rational and pragmatic approach to mitigate alcohol addiction and having flexibility to adapt in response to circumstance and needs. It is clear that the alcohol use behavior of people in the contemporary society

cannot be eliminated, and therefore a comprehensive public health framework with achievable goals should be developed and implemented to reduce harm caused by alcohol use [20, 24]. Harm reduction strategies of alcohol use should be practical approaches that have a sense of humanism.

Harm reduction approaches

There are some proven strategies at an individual and community level to reduce harm caused by alcohol use [1, 14, 15]. Injury and violence, road accidents due to drinking and driving and social harm related to alcohol use can be more effectively reduced by these strategies.

Promote safe drinking behavior

Planning and preparation before drinking reduces many negative consequences associated with alcohol use [15, 22]. It is observed that drinking alone at home can be much safer than going out and drinking in public. Taking all necessary steps to ensure that you do not harm yourself or others after drinking such as to use public transportation after drinking, developing a habit of giving your vehicle keys to spouse or a trusted friend before drinking, take precautions to have safe sex after drinking would ultimately save the user from health and relationship hazards. Being well-hydrated and having full stomach before taking alcohol would help alcohol users to drink more slowly and to get alcohol absorbed slowly to the bloodstream.

Reduce amount and frequency of drinking

Frequent alcohol users can plan to have at least one or two abstinence days and strive to increase days of abstinence gradually [22, 25]. Attempts to reduce the number of drinks you drink per occasion and switching from drinking spirits to beer or wine time to time are effective tactics for harm reduction.

Buy alcoholic beverages only when you drink

This strategy is not for everyone, but some people who primarily drink at home choose not to have alcohol in their house on abstinence days [25, 26] and they buy it only on the days when they intend to drink.

Increase public awareness of harmful use of alcohol and professional help for alcohol addicts

Health education and awareness programmes by healthcare professionals targeted at alcohol users and general public would make a big impact on controlling alcohol related harm [1, 11, 15, 27-29]. Detoxification services, therapy and counseling using face-to-face motivational interviews backed up with cognitive and behavioral therapy would help alcohol users to develop coping mechanisms and strategies to maintain limits in alcohol use and sobriety. Digital platforms are being extensively utilised today for this purpose. In this endeavor, multi-sectorial collective efforts from communities, organisations, and individuals, and training causes for health professionals are needed. Facilitation programs for alcohol users to get access to healthcare services. Peer support mechanisms have also been identified as effective methods in reducing harm caused by alcohol use. In Sri Lanka, monitoring and surveillance systems of persons with alcohol use disorders are needed.

Regulation of alcohol outlet density and maintenance of limits on days or hours of alcohol sales

It is observed that alcohol availability is associated with misuse of alcohol and alcohol-related problems [25 -27, 30]. Thus, limiting outlet density would decrease accessibility and eventually reduce the incidence of alcohol related problems and it is considered as one of the most effective policy measures for influencing alcohol consumption and related harms. Further, policies that restrict the hours that alcoholic beverages may be available for sale is an effective strategy for reducing excessive alcohol consumption and related harms.

Increase alcohol taxes

Increasing taxes and prices on alcoholic beverages is considered as an effective public health strategy for reducing alcohol-related harm [1, 11, 31]. Evidences indicate that higher alcohol prices tend to make substantial reductions in underage drinking and consumption levels of heavy drinkers. In countries like Sri Lanka where per capita income is relatively low, this policy approach is highly effective in reducing harm caused by alcohol use.

Increase enforcement of laws that prohibit sales to minors

Enact and enforce an appropriate minimum age for purchase and possession of alcoholic beverages and compliance checks at places liquor shops, bars, restaurants, and other places where liquor is for sale, would be effective in controlling alcohol related harm [10, 11, 29]. These actions would reduce underage drinking and related social issues and they serve as preventive measures against potential harm for minors.

Restrict or ban promotions of alcoholic beverages

The alcohol industry makes efforts to promote alcohol especially for women and young people through sponsorships and activities targeting at young people [1, 32, 33]. Promoting wine as a woman's drink and emphasising the myths such as alcohol is a stress reliever in the contemporary busy and demanding lives of women. The alcohol industry sponsors social and music events, covertly, targeting young and middle- aged women to break traditional alcohol consumption norms in Sri Lanka. Since the policies and other interventions aimed at regulating alcohol marketing is often weak in Sri Lanka, the interactions of the alcohol industry, political, economic and sociocultural factors drive alcohol-related harm in the country. Evidence-based sustainable policy actions are needed to combat promotions of alcoholic beverages which tend to increase harm caused by alcohol. Alcohol advertising on the internet and social media remains largely unregulated.

Implications and future directions

Alcohol is one of the top 10 contributors to the global burden of disease. Social, economic and environmental damages caused by alcohol use are substantial impediments to health and wellbeing of the people across the world, particularly for those living in low and middle income countries. Emerging marketing trends of alcohol use in Sri Lanka such as glamorising alcohol use among adolescents and young, particularly among young women, continues to pose detrimental effects on health outcomes of

Sri Lankans in general. These developments would sabotage the country's efforts in achieving sustainable development goals by 2030. On the other hand, there is a strong global trade in alcohol impacting the capacity of the government of Sri Lanka to intervene and regulate alcohol in a manner protective of the health and wellbeing of Sri Lankans. Tourist and import and export industry in the country that account for a substantial section of the Sri Lanka's economy are strongly linked to alcohol industry. Thus, abstinence may not be a pragmatic approach in controlling negative consequences of alcohol use behavior in Sri Lanka. Harm reduction approach therefore appears to be a viable option for Sri Lanka in mitigating the overall harm caused by the use of alcohol.

By providing alcohol users with accurate information and education about safer alcohol use practices such as adjusting consumption levels and frequency, or methods to maintain a healthier and safer drinking environment or motivating them to maintain healthy relationships with family members and with the society are cost-effective approaches in harm reduction. Health promotion approaches such as facilitating alcohol users to control their abusive and deviant behaviors such as aggression and violence by providing access to treatments, counseling and social support services would also be cost-effective and result-oriented harm reduction strategies. However, it seems that these alcohol preventive and control mechanisms were not considered or have not been given due attention in the contemporary healthcare and social service systems prevailing in the country. Implementation of availability restrictions or of comprehensive bans on alcohol marketing and price increase would be effective public health strategies in harm reduction. It was noted that in Sri Lanka, increases in alcohol taxation are not parallel to the regular price increases caused by inflation. Thus alcohol has become more affordable for the majority.

Strong commitment and collaboration from the government and other agencies involved in social and economic development of the country is needed to plan and implement harm reduction and preventive strategies. Multi-sectorial approach and capacity building in the health workforce is needed in this endeavor. Harm reduction approaches should be based on scientific evidences, but it was observed that biomedical, epidemiological and legislative research on alcohol use, particularly harm reduction of alcohol use, in Sri Lanka is limited. Most of the research findings of harm reduction are based on self-reporting, leaving avenues to question reliability of the findings. Alcohol research, mainly clinical trials of alcohol harm reduction, should be given priority by government and other research funding agencies in the country, and research evidences should be properly utilised to inform policy makers. Further, soft policies such as the establishment of a national plan or an alcohol production and sales monitoring system may not be impactful in reducing alcohol related harm. Harm reduction strategies and policies in Sri Lanka should be aligned with the objectives of the WHO's Global Strategy to Reduce the Harmful Use of Alcohol, Global Action Plan for the Prevention and Control of NCDs and Sustainable Development Goals for better results [1, 34, 35].

Conclusion

Alcohol is a growing and a vital public health issue in Sri Lanka. Detrimental consequences of alcohol use are more severe than such consequences caused by other addictive substances prevailing in the country. Social image of alcohol use, and trade and political links the alcohol industry has with other commodities and industries make it extremely difficult to accomplish complete abstinence although it is the safest and definite way to avoid alcohol related negative consequences occurring in the country. Harm reduction approach of alcohol use that aimed at reducing harmful consequences of alcohol use would be a feasible solution to mitigate the damage caused by alcohol use. Country specific strategies aiming at lowering the consumption levels of alcohol and related consequences such as health education and promotion programs for the users, tax increases and control of alcohol promotion should be developed and promoted using collaborative efforts. Such efforts should be aligned with the international alcohol control mechanisms and policies for better outcomes.

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