

RESEARCH

Open Access



Prevalence and patterns of multiple long-term conditions among lymphatic filariasis patients in Odisha, India: a community-based cross-sectional study

Abhinav Sinha¹, Prakash Kumar Sahoo^{1*}, Krushna Chandra Sahoo¹, Patrick Highton^{2,3}, Shubhashisha Mohanty⁴, Trupti Nayak⁴, Akshya Kumar Prusty⁵, Sujata Choudhury⁵, Barsha Kumari⁶, Karl Puchner⁷, Kamlesh Khunti^{2,3} and Sanghamitra Pati^{1*}

Abstract

Introduction Neglected tropical diseases (NTDs), such as lymphatic filariasis, mimic other chronic conditions and share common risk behaviors with parallel health system issues that require unique interventions. Multiple long-term conditions (MLTCs or multimorbidity), defined as two or more chronic conditions has become increasingly common in low- and middle-income countries (LMICs) such as India. However, data on the prevalence of the interface between NTDs and other chronic conditions are lacking. We estimated the prevalence and correlates of MLTC, assessed the commonly occurring patterns, and investigated the association between self-rated health (SRH) and the number of chronic conditions among patients with lymphatic filariasis.

Methods A cross-sectional study was conducted in Odisha, India, using a prevalidated MLTC assessment tool. We employed systematic random sampling to recruit 584 participants aged ≥ 18 years having lymphatic filariasis. MLTC was defined as the coexistence of one or more chronic conditions along with lymphatic filariasis. A multivariable logistic regression model was used to identify the correlates presented as adjusted odds ratios (AORs) with 95% confidence intervals (CIs). A hierarchical cluster analysis was conducted to identify the major clusters of chronic conditions. An ordinal regression model was used to assess the association between SRH and the number of chronic conditions.

Results The overall prevalence of MLTC was 68.8% (95% CI: 64.9–72.6), while the mean number of chronic conditions was 2 ± 2.3 . The chance of having MLTCs was greater among males [AOR: 3.9 (95% CI: 2.1–7.3)] than females. Participants with education at the primary and secondary school levels had greater odds of having MLTC [AOR: 2.2 (95% CI: 1.3–3.7)] and [AOR: 2.3 (95% CI: 1.3–3.8)], respectively. The commonly observed triad was lymphatic filariasis

*Correspondence:
Prakash Kumar Sahoo
shuvaprakash@gmail.com
Sanghamitra Pati
drsanghamitra12@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

with arthritis and peptic ulcer disease (1.5%), while the most common tetrad was lymphatic filariasis, hypertension, diabetes and peptic ulcer disease (0.7%). There was a per unit decrease in SRH with each additional chronic condition.

Conclusion We observed a high prevalence of MLTC among people with lymphatic filariasis. The findings of this study will not only be useful for both resource and planning in India but also in similar LMICs with a high burden of lymphatic filariasis.

Keywords Lymphatic filariasis, Multiple long-term conditions, Chronic conditions, Neglected tropical diseases, India, Multimorbidity

Introduction

The syndemic of both prevailing chronic infectious diseases and increasing non-communicable diseases (NCDs) is peculiar to low- and middle-income countries (LMICs), which have become a significant public health issue, especially for vulnerable populations [1]. Neglected Tropical Diseases (NTDs) such as chronic lymphatic filariasis closely resemble clinical manifestations of the NCDs and disproportionately affects the extreme poor living among the wealthy (The Blue Marble Health Effect) leading to long-term disability [2]. Additionally, overlap of symptoms makes differential diagnosis hard, along with high likelihood of these diseases being syndemic in the community and the individual patient as well [3]. The overlapping clinical manifestations could be lower extremities/scrotal edema (differential diagnosis: heart failure, cirrhosis with ascites, malnutrition), myoskeletal pain due recurrent inflammatory episodes (differential diagnosis: arthritis, and other acute infections such as dengue), pulmonary eosinophilia (differential diagnosis: asthma, and chronic obstructive pulmonary disease) [4]. Furthermore, it places an additional burden on health systems along with economic and societal consequences, including inability to work, loss of wages, debt due to catastrophic health expenditures, stigma and a reduced societal role [5, 6]. Additionally, these individuals also require a lifelong continuity of care that further compounds the challenges for both the health system and care givers [7].

Nearly half of the world's cases of lymphatic filariasis are found in South Asia, with India having more than 23 million cases and 650 million people at risk [8, 9]. The National Filaria Control Program in India adopts a dual strategy of annual mass drug administration (MDA) and morbidity management and disability prevention (MMDP) with the aim of eliminating the disease by 2027 [10]. The program may achieve its goal of halting further transmission of the infection, but individuals with the disease will live for many years to come. Although there is a paucity of evidence on the link between NCDs and lymphatic filariasis, certain risk factors, such as reduced mobility and physical activity due to pain and swelling, are known causes of obesity and other cardiometabolic diseases [11, 12]. Previous studies suggest that 5.09 million disability-adjusted life years (DALYs) are liable to the

burden of depression among lymphatic filariasis patients [13]. Moreover, studies have also documented the association of diabetes with lymphatic filariasis [14]. Hence, the interaction between lymphatic filariasis and NCDs contributes to the emergence of syndemics that lead to a greater risk of having other chronic conditions that may lead to multiple long-term conditions (MLTCs).

Multiple long-term conditions (MLTC or multimorbidity), the simultaneous existence of two or more chronic conditions, may include an NCD such as hypertension or a chronic infectious disease such as tuberculosis or a mental health condition such as depression in an individual that has led to an increase in triple burden of diseases [15]. A systematic review reported that the prevalence of MLTCs in individuals with chronic communicable and non-communicable diseases varied from 13 to 87%, while another meta-analysis reported that the overall prevalence of MLTC was approximately 20% in India [16, 17]. MLTC is significantly associated with poorer patient-reported outcome measures, deteriorated physical and mental functioning, and compromised health-related quality of life (HRQoL) [18–21]. Additionally, it also contributes to a significant overload on already swamped healthcare systems along with out-of-pocket expenditures [22]. Nonetheless, patients with MLTC visit multiple healthcare providers and specialists for each chronic condition, as existing guidelines as well as care at the public health facilities are fragmented and do not focus on managing multiple long-term conditions concurrently [23]. These challenges compound among lymphatic filariasis patients and thus call for both resources and planning to identify complex and effective interventions. However, this could be limited by the constraint of data on the prevalence of MLTC among lymphatic filariasis patients; hence, we aimed to estimate the prevalence of MLTC and assess its risk factors among adults with lymphatic filariasis. We also identified the commonly occurring patterns of MLTC and assessed the association of self-rated health (SRH) with the number of chronic conditions in these individuals.

Methods

Study design and setting

A cross-sectional study was conducted in the Cuttack district of Odisha from April 2023 to October 2023. Odisha is a coastal state in the Eastern part of India with a population of approximately 45 million. Odisha is endemic for lymphatic filariasis, with recent evidence suggesting 13.8% filarial antigenicity in the region [5].

Study population

This study was conducted among individuals aged 18 years and above with chronic lymphatic filariasis. We included participants who provided informed written consent. We excluded bedridden patients, those with severe cognitive impairment (approximately <5% of the sampled population) and those unable to provide consent.

Sample size and sampling

The calculation of the sample size was predicated on specific parameters, including the population size (N) with a finite population correction factor, a hypothesized 50% frequency of the prevalence of MLTC among lymphatic filariasis patients (p), 95% confidence limits ($Z_{1-\alpha/2}=1.96$), precision ($d=0.1$), and the design effect for cluster surveys ($DEFF=1.4$). The sample size (n) was determined using the following equation: $n = [DEFF * N * p(1-p)] / [(d^2 / Z^2 * 1-\alpha/2 * (N-1) + p * (1-p))]$ [24]. The resulting minimum sample size was determined to be 538. Furthermore, a 10% nonresponse rate was added, resulting in a final sample size of approximately 592.

The Cuttack district is divided into 14 blocks that receive mass drug administration (MDA) for lymphatic filariasis elimination. We conducted a survey to estimate the coverage and compliance of MDA in Cuttack during 2021, where we received a line list of all chronic lymphatic filariasis patients from the State National Vector Borne Disease Control Programme (NVBDPC) [25]. Following a multistage systematic random sampling method, we randomly selected one village from each of the 14 blocks for this study. Furthermore, from the list of all the lymphatic filariasis patients in each village, we systematically selected every third patient. We identified and contacted these patients through community health workers (Accredited Social Health Activist, ASHA).

Data collection and management

The data were collated using a pre-validated tool, the Multimorbidity Assessment Questionnaire for Primary Care (MAQ-PC) [26]. The MAQ-PC was developed iteratively to assess self-reported chronic conditions and has been used in diverse settings, including community surveys. All twenty-six included chronic conditions were self-reported in nature and were triangulated with

the help of ASHA. The participants were interviewed face-to-face via Open Data Kit Collect (ODK), a mobile application based on Android. If any participant was not available on the day of the survey, we fixed a prior time with the help of ASHA for a follow-up visit. A pre-specified standard protocol was followed to train all the data collectors who were from a public health background. The investigators also personally oversaw the data collection and checked that the methodology was adhered to. In addition, 10% of the data were verified at random to guarantee correctness.

Variables

The ages of the participants were recorded in years and grouped as 18–30 years, 31–45 years, 46–60 years, 61–80 years and ≥ 81 years. Various other sociodemographic attributes, such as sex (male/female), residence (urban/rural), caste/social class (scheduled caste, scheduled tribe, other backward class, and general), marital status (currently married, never married, separated/widow, and live-in), education (no formal education, primary, secondary, and higher), occupation (currently working, currently not working, homemaker, retired), economic status (deprived, middle, affluent), and health insurance (yes/no), were included in the analysis.

Statistical analysis

An Excel spreadsheet with the data was downloaded from the server. Outliers, duplicates, and missing values were removed from the data. We used Stata v. 17.0 (Stata Corp., Texas) to analyze the data. The mean and standard deviation (SD) of age were reported. Both the MLTC and the prevalence of each chronic illness were reported using the frequency and percentage. Furthermore, we included 95% confidence intervals (CIs) for each proportion as a way to quantify uncertainty. The primary focus was on the prevalence of MLTC, which was determined by counting the number of chronic conditions that an individual reported on their own. Individuals with lymphatic filariasis and at least one other chronic ailment were included in the working definition of MLTC. The associations between MLTC and other sociodemographic variables were evaluated using a bivariate logistic regression model. The strength of this association was indicated by the odds ratios (ORs) and 95% confidence intervals (CIs). Additionally, the risk factors were identified using a multivariable logistic regression model that was adjusted for several sociodemographic attributes such as age, sex, residence, caste, education, occupation, marital status, economic status, and health insurance. The results were shown as adjusted odds ratios (AORs) with 95% confidence intervals.

Pattern analysis was used as a simple matrix approach with exhaustive analysis of all possible combinations

of chronic conditions with lymphatic filariasis using a descriptive statistical method [27]. All conditions with a prevalence of more than 0.5% were included in the analysis. The combinations of two chronic conditions/dyad, three conditions/triad, and four conditions/tetrad (of which one was lymphatic filariasis) were reported. Furthermore, a hierarchical cluster analysis using Gower's dissimilarity matrix was conducted to identify the major clusters of chronic conditions [28]. Furthermore, we followed the hierarchical agglomerative ward linkage method to obtain the hierarchy of clusters by grouping

the conditions belonging to the same cluster, presented as a dendrogram [28].

We used an ordinal regression model to assess the association between self-rated health (SRH) and the number of chronic conditions grouped as none, one, two, three, or four or more conditions expressed as AORs with 95% CIs. This model was adjusted for age, sex and health insurance.

Ethical considerations

The Institutional Human Ethics Committee of the ICMR-Regional Medical Research Centre, Bhubaneswar, gave its approval to this study (reference no: ICMR-RMRCB/IHEC-2021/51). The State Research and Ethics Committee, the Directorate of Health Services, and the Government of Odisha granted approval for the study to be carried out. Prior to participation, all subjects provided written, informed consent. The anonymity of the data was preserved, and each participant's privacy was protected.

Results

A total of 627 patients who had lymphatic filariasis were enrolled, 584 consented to participate in the study, for a response rate of 93%. The main reasons for not participating in the survey were lack of time and non-availability of any direct benefits. The participants' mean age was 62.1 ± 11.1 years. 51.7% of the participants were female, and 47.8% of the participants were between the ages of 61 and 80. Most of the participants (43%) did not have any formal education, and approximately 60% belonged to deprived socioeconomic strata. A majority of the respondents (84.8%) had health insurance. Table 1 displays the respondents' complete sociodemographic profile.

With a prevalence of 29.3%, hypertension was the most common chronic condition, followed by peptic ulcer disease (26.9%), visual impairment (people who have vision problems even when wearing glasses) (23.9%), arthritis (21.9%), and diabetes (14.1%). Supplementary Table 1 lists each chronic condition's prevalence. The average number of long-term conditions was 2 ± 2.3 , and overall 68.8% (95% CI: 64.9–72.6) of patients had MLTC. Those over the age of 81 years had a higher prevalence of MLTC. Males had MLTC at a higher rate than females (76.2% vs. 61.9%, respectively). The prevalence of MLTC was greater among those living in deprivation than among their affluent counterparts (68.6% vs. 63.5%, respectively). Participants with or without health insurance had an almost equal prevalence of MLTC (Table 2).

Age above 60 years [OR: 14.9 (95% CI: 1.7–129.9)], male sex [OR: 1.9 (95% CI: 1.4–2.8)], and fewer years of education [OR: 2.1 (95% CI: 1.3–3.3)] were found to be significant predictors of MLTC in the bivariate logistic regression model (Table 2). The multivariable logistic

Table 1 Sociodemographic profile of the study participants (N = 584)

Attributes	n (%)
Age (years)	
18–30	6 (1.1)
31–45	79 (13.5)
46–60	184 (31.5)
61–80	279 (47.8)
≥ 81	36 (6.2)
Sex	
Female	302 (51.7)
Male	282 (48.3)
Residence	
Rural	558 (95.5)
Urban	26 (4.4)
Caste	
Scheduled Caste	66 (11.3)
Scheduled Tribe	12 (2.1)
Other Backward Class	240 (41.1)
General	266 (45.5)
Education	
No formal education	251 (42.9)
Primary	156 (26.7)
Secondary	166 (28.4)
Higher	11 (1.9)
Occupation	
Currently working	131 (22.4)
Currently not working	202 (34.6)
Homemaker	239 (40.9)
Retired	12 (2.1)
Marital Status	
Never Married	18 (3.1)
Currently Married	396 (67.8)
Separated/Widow	169 (28.9)
Live-in	1 (0.1)
Economic Status	
Deprived	350 (59.9)
Middle	182 (31.2)
Affluent	52 (8.9)
Health Insurance	
Yes	495 (84.7)
No	89 (15.2)

Table 2 Prevalence of MLTC and its association across various sociodemographic attributes

Factors	MLTC N, % (CI)	Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Age (years)			
18–30	1, 16.7 (0.4–64.1)	Reference*	Reference
31–45	43, 54.4 (42.8–65.7)	5.9 (0.7–53.5)	11.5 (1.1–130.1)
46–60	120, 65.2 (57.9–72.1)	9.4 (1.1–81.9)	20.3 (1.8–225.1)
61–80	209, 74.9 (69.4–79.9)	14.9 (1.7–129.9)	33.1 (2.9–371.6)
≥ 81	29, 80.6 (63.9–91.8)	20.7 (2.1–206.6)	50.9 (3.9–651.9)
Sex			
Female	187, 61.9 (56.2–67.4)	Reference	Reference
Male	215, 76.2 (70.8–81.1)	1.9 (1.4–2.8)	3.9 (2.1–7.3)
Residence			
Rural	15, 57.7 (36.9–76.6)	Reference	Reference
Urban	387, 69.3 (65.3–73.2)	0.6 (0.3–1.3)	0.5 (0.2–1.1)
Caste			
Scheduled Caste	50, 75.8 (63.6–85.5)	2.1 (1.1–3.8)	2.4 (1.2–4.7)
Scheduled Tribe	7, 58.3 (27.7–84.8)	0.9 (0.3–2.9)	1.4 (0.4–4.9)
Other Backward Class	185, 77.1 (71.2–82.2)	2.2 (1.5–3.3)	2.1 (1.3–3.1)
General	160, 60.1 (53.9–66.1)	Reference	Reference
Education			
No formal education	156, 62.1 (55.8–68.2)	Reference	Reference
Primary	121, 77.6 (70.2–83.8)	2.1 (1.3–3.3)	2.2 (1.3–3.7)
Secondary	116, 69.9 (62.3–76.7)	1.4 (0.9–2.1)	2.3 (1.3–3.8)
Higher	9, 81.8 (48.2–97.7)	2.7 (0.6–12.9)	8.3 (1.4–50.4)
Occupation			
Currently working	84, 64.1 (55.3–72.3)	1.3 (0.4–4.2)	3.2 (0.8–12.9)
Currently not working	149, 73.8 (67.1–79.7)	2.1 (0.6–6.6)	5.4 (1.4–21.2)
Homemaker	162, 67.8 (61.4–73.7)	1.5 (0.5–4.9)	11.6 (2.7–49.9)
Retired	7, 58.3 (27.7–84.8)	Reference	Reference
Marital Status			
Never Married	8, 44.4 (21.5–69.2)	Reference	Reference
Currently Married	276, 69.7 (64.9–74.2)	2.9 (1.1–7.5)	1.3 (0.4–4.1)
Separated/Widow	118, 69.8 (62.3–76.6)	2.9 (1.1–7.7)	1.8 (0.5–5.7)
Live-in	0	Empty	Empty
Economic Status			
Deprived	240, 68.6 (63.4–73.4)	1.3 (0.7–2.3)	1.1 (0.5–2.1)
Middle	129, 70.9 (63.7–77.4)	1.4 (0.7–2.7)	1.3 (0.6–2.6)
Affluent	33, 63.5 (48.9–76.4)	Reference	Reference
Health Insurance			
Yes	341, 68.9 (64.6–72.9)	0.9 (0.6–1.6)	1.1 (0.6–1.8)
No	61, 68.5 (57.8–77.9)	Reference	Reference

*Reference: The baseline group against which other categories are compared in the regression

regression model showed that increasing age was significantly associated with higher odds of having MLTCs, after adjusting for various sociodemographic factors (Table 2). Participants over 80 years of age had higher odds of MLTC [AOR: 50.9 (95% CI: 3.9–651.9)] than those in younger age groups. Males had a higher odds of MLTC than females [AOR: 3.9 (95% CI: 2.1–7.3)]. Primary and secondary school participants were more likely to have MLTC [AOR: 2.2 (95% CI: 1.3–3.7)] and [AOR: 2.3 (95% CI: 1.3–3.8)], respectively, than those without formal education. Participants who did not currently

work [AOR: 5.4 (95% CI: 1.4–21.2)] were observed to have higher odds of having MLTC than their retired counterparts.

The most commonly observed triads included lymphatic filariasis with arthritis and peptic ulcer disease, and lymphatic filariasis with hypertension and diabetes, each with a prevalence of 1.54%, followed by lymphatic filariasis with hypertension and peptic ulcer disease (1.2%). The most common tetrads were lymphatic filariasis with hypertension, diabetes, and peptic ulcer disease, and lymphatic filariasis with arthritis, peptic ulcer

disease, and visual impairment, each with a prevalence of 0.7% (Table 3). The dendrogram represents the most common clusters (Fig. 1).

With each additional chronic disease, there was a significant per-unit decline in self-rated health, according to the ordinal regression model adjusted for age, sex, and health insurance (Table 4).

The greatest deterioration was observed among participants with four or more chronic conditions [AOR: 5.9 (95% CI: 3.5–9.9)].

Discussion

This is the first study to use a random sample to look into the prevalence of MLTC in patients with lymphatic filariasis. We observed hypertension to be the most common comorbid chronic condition, followed by peptic ulcer disease, visual impairment, arthritis, and diabetes, which is in contrast with the findings of another study conducted among 323 tuberculosis patients in two states of India that reported depression to be the most prevalent condition, followed by diabetes, peptic ulcer disease, and hypertension [29]. Nonetheless, hypertension,

diabetes, and peptic ulcer disease had the highest prevalence across both studies that looked at the interface of chronic infectious disease with non-communicable diseases. A probable reason for this could be that patients with lymphatic filariasis share the exposure to the drivers of NCDs in India. Moreover, a few studies also highlight that lymphatic filariasis patients have chronic inflammation due to lymphedema and elephantiasis, which may contribute to the development of cardiometabolic diseases, as proinflammatory immune responses increase the onset of these conditions [30]. Additionally, arthritis attributable to *Wuchereria bancrofti* has been reported among Indian patients, and its pathogenesis is linked to immune complex deposition or inflammation due to the presence of adult worms in the joint space [31].

The prevalence of MLTC in our study was greater than that reported in a study conducted in two states of India i.e. Telangana and Odisha, in which the prevalence of multimorbidity among tuberculosis patients was approximately 52% [29]. Additionally, a study conducted among human immunodeficiency virus (HIV) patients reported that the prevalence of multimorbidity was approximately 48% [32]. Nonetheless, the prevalence of MLTC among lymphatic filariasis patients is greater than the global pooled prevalence of multimorbidity, which is approximately 37%, as reported by a recent systematic review based on 126 peer-reviewed studies [33]. However, it is worth noting that the mean age of participants in our study was around 62.1 years which may be one of the reasons for higher prevalence of MLTCs in this study. However, this highlights the need for the assessment of MLTCs among lymphatic filariasis patients to design evidence-based policies in the future to provide continuity of care for these individuals.

The chances of having MLTC increased with increasing age, which is consistent with the findings of a systematic review that identified older age to be a risk factor for multimorbidity [34], while another systematic review conducted with the aim of identifying risk factors for multimorbidity also showed that increased age was positively associated with multimorbidity [35]. A study conducted in Delhi, India also reported that multimorbidity increased with age, which is in agreement with the findings of our study [36]. This finding highlights two major areas to be focused upon, the first being the demographic shift, which will lead to the addition of an aging population who will require healthcare services. Second, India is attempting to eliminate lymphatic filariasis by 2027 (three years ahead of the global target), which means that further transmission will be interrupted with no new cases [10]. However, patients with existing lymphatic filariasis can survive for many years. Additionally, the burden of MLTC, as indicated by the present study, is high in this group; hence, these individuals will require quality

Table 3 Patterns (frequently occurring combinations) of diseases among patients having lymphatic filariasis (N = 584)

S. No	Pattern with Lymphatic Filariasis	Prevalence n (%)
Dyad		
1	Hypertension	34 (5.8)
2	Diabetes	17 (2.9)
3	Peptic Ulcer Disease	15 (2.6)
4	Arthritis	10 (1.7)
5	Chronic Alcoholism	8 (1.4)
6	Chronic Lung Disease	7 (1.2)
7	Visual Impairment	4 (0.7)
8	Chronic heart disease	4 (0.7)
9	Sleep Disorder	4 (0.7)
10	Leprosy	3 (0.5)
11	Thyroid Disease	3 (0.5)
12	Cancer	3 (0.5)
13	Psoriasis	3 (0.5)
Triad		
1	Hypertension + Diabetes	9 (1.5)
2	Arthritis + Peptic Ulcer Disease	9 (1.5)
3	Hypertension + Peptic Ulcer Disease	7 (1.2)
4	Visual Impairment + Peptic Ulcer Disease	5 (0.9)
5	Arthritis + Hypertension	4 (0.7)
6	Visual Impairment + Arthritis	4 (0.7)
7	Visual Impairment + Hearing Impairment	4 (0.7)
8	Chronic Lung Disease + Peptic Ulcer Disease	3 (0.5)
9	Hypertension + Visual Impairment	3 (0.5)
10	Arthritis + Chronic Lung Disease	3 (0.5)
Tetrad		
1	Hypertension + Diabetes + Peptic Ulcer Disease	4 (0.7)
2	Arthritis + Peptic Ulcer Disease + Visual Impairment	4 (0.7)

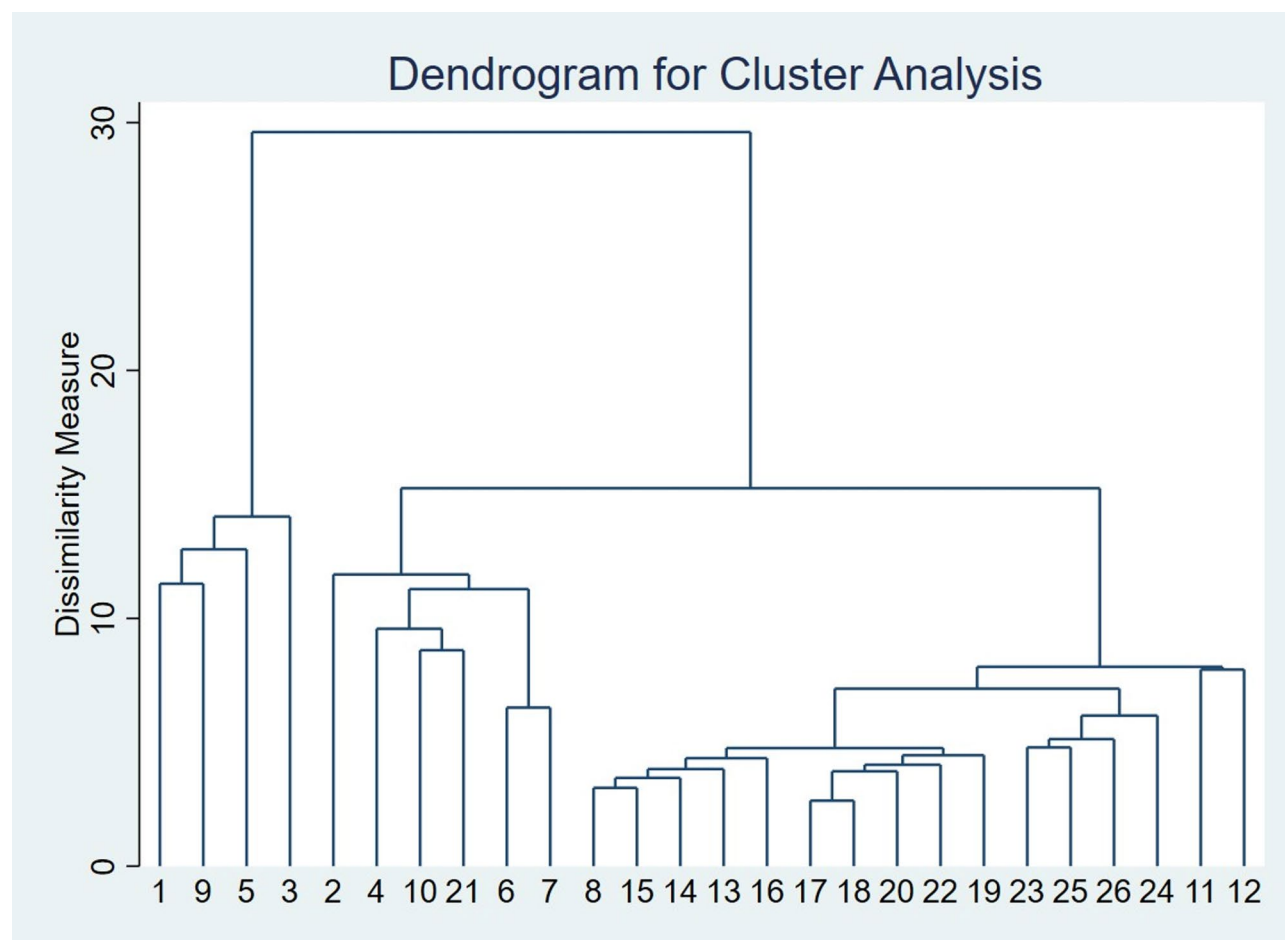


Fig. 1 Dendrogram representing the clustering of chronic conditions among lymphatic filariasis patients

*Footnotes: 1: Arthritis, 2: Diabetes, 3: Hypertension, 4: Chronic lung disease, 5: Peptic ulcer disease, 6: Chronic back pain, 7: Chronic heart disease, 8: Stroke, 9: Visual impairment, 10: Hearing impairment, 11: Dementia, 12: Chronic alcoholism, 13: Cancer, 14: Chronic kidney disease, 15: Epilepsy, 16: Thyroid disorders, 17: Tuberculosis, 18: Leprosy, 19: Irritable bowel syndrome, 20: Chronic constipation, 21: Sleep disorder, 22: Chronic liver diseases, 23: Psoriasis, 24: Eczema, 25: Chronic rhinitis, 26: Depression

Table 4 Ordered logistic regression showing association between self-rated health with number of chronic conditions among lymphatic filariasis patients

Attribute	AOR (95% CI)
Number of chronic conditions	
None	Reference
One	2.1 (1.1–3.8)
Two	2.7 (1.5–4.7)
Three	5.5 (3.2–9.4)
Four or more	5.9 (3.5–9.9)

*adjusted for age, sex and health insurance

healthcare facilities, thus warranting the strengthening of primary care.

In our study, males were identified to be at a greater risk of having MLTC than their female counterparts, which is incongruous with the existing MLTC literature in India [21, 22, 36]. All studies to date have reported that females are at greater risk of having MLTC, whereas the

present study showed that males are at greater risk of having MLTC, which is a novel finding. A probable reason for this could be the gender roles assigned by society in India and other similar cultures. Despite having lymphatic filariasis, females perform household chores that involve physical activity, whereas males will rest if they are diagnosed with a disease leading to reduced physical activity, increased obesity and other risk factors for developing MLTC.

We observed that participants with more years of schooling had a greater chance of having MLTC, which is consistent with the findings of a systematic review that also revealed higher education to be directly associated with multimorbidity in Southeast Asia [37]. A probable reason for this could be that with education, people tend to be more health conscious and hence have better chances of being diagnosed and self-reported with chronic conditions. Nonetheless, this finding implies that

health literacy should be provided to people with no formal education or fewer years of education.

We observed that participants who did not work were at a greater risk of having MLTC, which is consistent with the findings of a systematic review that reported that not working or being unemployed increased the risk of having multimorbidity, particularly substance use patterns [38]. Moreover, studies have reported that socioeconomic marginalization increases the risk of multimorbidity, which stands true for patients with lymphatic filariasis, as this disease mostly affects the poorest people of the poor population and often leads to disability, contributing to a loss of livelihood opportunities [20–22, 39]. Hence, it is crucial to identify the care-seeking pathways of these patients to make the existing programmes more equitable.

The most commonly occurring pattern among patients with lymphatic filariasis was hypertension and diabetes, which is congruent with the findings of a systematic review that reported that cardiovascular and metabolic diseases were the most commonly observed multimorbidity patterns in Asia [40]. Our findings also align with the findings of another systematic review showing hypertensive diseases were the most frequent condition in all dyads, followed by gastrointestinal conditions, arthropathies and diabetes mellitus, in India and China [41].

There was a per unit decrease in self-rated health with an increase in the number of chronic conditions, which is in agreement with the findings of a systematic review that reported a mean decrease of -1.5% to -4.4% (varied depending on the scale used) in health-related quality of life (HRQoL) per added disease [42]. Notably, poor quality of life among our study population was a cumulative effect of MLTC, along with existing disability and functional decline due to chronic lymphatic filariasis, which needs to be addressed.

Implications for policy and practice

The findings suggest MLTC to be common among lymphatic filariasis patients, which calls for linking these patients to their nearest Ayushman Arogya Mandir (AAM) or primary healthcare centers formerly known as Health and Wellness Centers for continuity of care. AAMs are established with a vision to strengthen primary care by providing preventive and curative services in the patient's vicinity with an expanded range of services, especially those curated for chronic conditions. However, lymphatic filariasis is not included in this list despite being prevalent in 339 out of 766 districts across 20 states and Union Territories of India. Hence, the states should be directed to add locally important diseases to the list of AAMs, as health is a state subject in India. This will help in providing quality care to these patients

who would eventually help in achieving universal health coverage.

Individuals with lymphatic filariasis, as seen in our study, mostly belong to deprived strata of society and hence need additional support, which may cause them to incur out-of-pocket expenditures and the risk of impoverishment during treatment. Hence, MLTC among these patients is far more challenging and requires additional efforts to combat. Here, patient-centered holistic care for all ailments at one point/facility is of utmost importance as multiple (self-) referrals to a variety of specialists is not realistic due to disability and low socio-economic status.

Community health workers (newly recruited cadre of trained nurses) can play a major role in keeping track of these patients by regularly screening for common chronic conditions and managing multiple morbidities through periodical investigations, motivating regular physician visits and helping them in procurement as well as taking their medications. This could be brought under the ambit of the existing Morbidity Management and Disability Prevention (MMDP) component of the Lymphatic Filariasis Elimination Programme by further increasing its scope. Moreover, diabetes (via polyneuropathy) and hypertensive disease (via heart failure) might aggravate disability of lower extremities in LF patients making effective control of these co-morbidities essential for long term success of LF care.

Additionally, there is a need for family-based approaches for reducing shared risk factors for MLTC—that may require behavioral change interventions. Future studies should develop interventions to manage MLTC in this population. Addressing disparities in accessing healthcare and improving access to integrated healthcare services at a single platform may help in mitigating the burden of multiple chronic conditions among lymphatic filariasis patients [43].

Strengths and limitations

This novel study has a number of strengths, including the use of a random sample, the assessment of common MLTCs, a high response rate, and associations with a number of risk factors, but it was conducted in only one state of India. We used a pre-validated tool to assess MLTC, which was also one of the strengths of this study, but our data were limited by self-reported chronic conditions that may have resulted in recall bias. Nonetheless, we triangulated the self-reported data with those of community healthcare workers. We did not include phenotypic measurements, which was another limitation of the study. Additionally, we could not establish causality, as our study was cross-sectional in nature.

Conclusion

We observed a high prevalence of MLTC among lymphatic filariasis patients, which cannot be overlooked. The results of the present study will not only be useful for both resource and planning and for identifying effective interventions in India but also in similar LMICs with a high burden of lymphatic filariasis. Although more studies are required to explore the link between lymphatic filariasis and other chronic conditions, we must address the common risk factors and adopt integrated approaches for healthcare delivery for those with lymphatic filariasis and MLTC to prevent the onset of disease and improve overall quality of life among these individuals. Additionally, a majority of these individuals are from deprived sections of society, and thus, focusing on their continuum of care will also help in achieving universal health coverage.

Abbreviations

MLTC	Multiple long-term conditions
LMIC	Low-and middle-income countries
LF	Lymphatic Filariasis
AAM	Ayushman Arogya Mandir
HRQoL	Health-related quality of life

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-23525-2>.

Supplementary Material 1

Acknowledgements

The authors are grateful to the Government of Odisha and officials from the State National Vector Borne Disease Control Programme for their support in completing this study. We are also thankful to all our anonymous participants. We acknowledge the relentless efforts of our field team in collecting the data. KK is supported by the National Institute for Health Research (NIHR) Applied Research Collaboration East Midlands (ARC EM), the NIHR Global Research Centre for Multiple Long Term Conditions, the NIHR Cross NIHR Collaboration for Multiple Long Term Conditions and the NIHR Leicester Biomedical Research Centre (BRC).

Author contributions

Concept and design: AS, PKS and SP. Acquisition, statistical analysis, or interpretation of data: AS, PKS, KCS, SM, TN, AKP, SC, BK, and SP. Drafting of the manuscript: AS, PKS, and SP. Monitored analysis and critical revision of the manuscript for important intellectual content: KCS, PH, SM, TN, AKP, SC, KP, BK, and KK. Administrative and technical support: PKS, KCS, SM, TN, AKP, SC, BK, and SP. Supervision: SP. All authors reviewed the manuscript.

Funding

The present research was conducted as a part of the Royal Society of Tropical Medicine and Hygiene Early Career Grants Programme funded by the National Institute for Health and Care Research (NIHR), UK, using UK aid from the UK Government to support global health research. The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR or the UK government.

Data availability

The dataset analyzed during the current study will be made available upon reasonable request to the corresponding author.

Declarations

All methods were carried out in accordance with the relevant guidelines and regulations.

Ethics approval and consent to participate

This study was approved by the Institutional Human Ethics Committee of ICMR-Regional Medical Research Centre, Bhubaneswar (reference no: ICMR-RMRCB/IHEC-2021/51). Additionally, permission from the State Research and Ethics Committee, Directorate of Health Services, and Government of Odisha was obtained to conduct the study. Informed written consent was obtained from all the participants prior to participation. The data collected were stored anonymously, and the confidentiality of all participants was maintained.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹ICMR-Regional Medical Research Centre, Bhubaneswar, India

²Diabetes Research Centre, University of Leicester, Leicester General Hospital, Leicester LE5 4PW, UK

³National Institute for Health and Care Research Applied Research Collaboration East Midlands, Leicester, UK

⁴Directorate of Public Health, National Vector Borne Disease Control Programme, Government of Odisha, Bhubaneswar, India

⁵Regional Research Institute of Homeopathy, Puri, India

⁶South Asian Institute of Health Promotion, Bhubaneswar, India

⁷Laboratory of Primary Health Care, General Medicine and Health Services Research, Faculty of Health Sciences, School of Medicine, Aristotle University of Thessaloniki, Thessaloniki, Greece

Received: 7 January 2025 / Accepted: 9 June 2025

Published online: 05 July 2025

References

1. Bhatnagar T, Kaur P, Kumaraswami V. Links between the epidemiology and control of noncommunicable diseases and neglected tropical diseases in Asia. *Neglected Tropical Diseases-East Asia*. 2019;149–73.
2. Hotez PJ, NTDs. 2.0:blue marble health—neglected tropical disease control and elimination in a shifting health policy landscape. *PLoS Negl Trop Dis*. 2013;7(11):e2570.
3. Hotez PJ, Daar AS. The CNCDs and the ntds: blurring the lines dividing noncommunicable and communicable chronic diseases. *PLoS Negl Trop Dis*. 2008;2(10):e312.
4. Chandy A, Thakur AS, Singh MP, Manigauha A. A review of neglected tropical diseases: filariasis. *Asian Pac J Trop Med*. 2011;4(7):581–6.
5. Sinha A, Pati S, Sahoo PK. Investigating immunological interaction between lymphatic filariasis and COVID-19 infection: a preliminary evidence. *Hum Vaccines Immunotherapeutics*. 2021;17(12):5150–2.
6. Ratna P, Sinha A, Pati S, Sahoo PK. Factors influencing implementation of mass drug administration for lymphatic filariasis elimination: a mixed-method study in odisha, India. *Front Pharmacol*. 2024;15:1297954.
7. Caprioli T, Martindale S, Mengiste A, Assefa D, H/Kiros F, Tamiru M, Negussu N, Taylor M, Betts H, Kelly Hope LA. Quantifying the socioeconomic impact of leg lymphoedema on patient caregivers in a lymphatic filariasis and podoconiosis coendemic district of Ethiopia. *PLoS Negl Trop Dis*. 2020;14(3):e0008058.
8. Sinha A, Mohapatra S, Sahoo KC, Mohanty S, Sahoo B, Pati S, Sahoo PK. Motivation–opportunity–ability–behavior of community members and program implementers toward mass drug administration for lymphatic filariasis elimination in india: a systematic review and implementation priority. *Trans R Soc Trop Med Hyg*. 2024 Mar;20:trae008.
9. Sinha A, Mohapatra S, Pati S, Sahoo PK. Facilitators and barriers in implementation of mass drug administration for lymphatic filariasis elimination in india: A protocol for systematic review and qualitative meta-synthesis. *J Family Med Prim Care*. 2022;11(7):3844–50.

10. Dickson BF, Graves PM, McBride WJ. Lymphatic filariasis in Mainland South-east asia: a systematic review and meta-analysis of prevalence and disease burden. *Trop Med Infect Disease*. 2017;2(3):32.
11. Zeldenryk LM, Gray M, Speare R, Gordon S, Melrose W. The emerging story of disability associated with lymphatic filariasis: a critical review. *PLoS Negl Trop Dis*. 2011;5(12):e1366.
12. Koschorke M, Al-Haboubi YH, Tseng PC, Semrau M, Eaton J. Mental health, stigma, and neglected tropical diseases: A review and systematic mapping of the evidence. *Front Trop Dis*. 2022;3:808955.
13. Ton TG, Mackenzie C, Molyneux DH. The burden of mental health in lymphatic filariasis. *Infect Dis Poverty*. 2015;4:1–8.
14. Berbudi A, Ajendra J, Wardani AP, Hoerauf A, Hübner MP. Parasitic helminths and their beneficial impact on type 1 and type 2 diabetes. *Diab/Metab Res Rev*. 2016;32(3):238–50.
15. Khunti K, Sathanapally H, Mountain P. Multiple long term conditions, multimorbidity, and comorbidities: we should reconsider the terminology we use. *BMJ: Br Med J (Online)*. 2023;383:p2327.
16. Kalulu L, Asogwa OA, Marzà-Florensa A, Kyobutungi C, Levitt NS, Boateng D, Klipstein-Grobusch K. Multimorbidity of communicable and noncommunicable diseases in low-and middle-income countries: A systematic review. *J Multimorbidity Comorbidity*. 2022;12:26335565221112593.
17. Varanasi R, Sinha A, Bhatia M, Nayak D, Manchanda, Janardhanan R, Lee JT, Tandon S, Pati S. Epidemiology of chronic disease Multimorbidity in india: a systematic review and meta-analysis. *J Multimorbidity Comorbidity*. 2024.
18. Puri P, Sinha A, Mahapatra P, Pati S. Multimorbidity among midlife women in india: well-being beyond reproductive age. *BMC Womens Health*. 2022;22(1):117.
19. Sinha A, Varanasi R, Pati S. Kaleidoscopic use of world health organization's study on global ageing and adult health data set to explore Multimorbidity and its outcomes in low and middle-income countries: an insider view. *J Family Med Prim Care*. 2021;10(12):4623–5.
20. Pati S, Sinha A, Verma P, Kshatri J, Kanungo S, Sahoo KC, Mahapatra P, Pati S, Delipino FM, Krolow A, da Cruz Teixeira DS. Childhood health and educational disadvantage are associated with adult Multimorbidity in the global south: findings from a cross-sectional analysis of nationally representative surveys in India and Brazil. *J Epidemiol Community Health*. 2023;77(10):617–24.
21. Sinha A, Kanungo S, Bhattacharya D, Kaur H, Pati S. Noncommunicable disease Multimorbidity among tribal older adults in india: evidence from study on global ageing and adult health, 2015. *Front Public Health*. 2023;11:1217753.
22. Sinha A, Kerketta S, Ghosal S, Kanungo S, Pati S. Multimorbidity among urban poor in india: findings from LASI, wave-1. *Front Public Health*. 2022;10:881967.
23. Mangin D, Heath I, Jamouille M. Beyond diagnosis: rising to the Multimorbidity challenge. *BMJ*. 2012;344.
24. Charan J, Kaur R, Bhardwaj P, Singh K, Ambwani SR, Misra S. Sample size calculation in medical research: A primer. *Ann Natl Acad Med Sci (India)*. 2021;57(02):074–80.
25. Sinha A, Mohapatra S, Mohanty S, Pati S, Sahoo PK. Mass drug administration for lymphatic filariasis elimination amidst COVID-19 pandemic in odisha, india: A step toward achieving SDG-3. *Trop Doct*. 2022;52(4):556–9.
26. Pati S, Hussain MA, Swain S, Salisbury C, Metsemakers JF, Knottnerus JA, Akker MV. Development and validation of a questionnaire to assess multimorbidity in primary care: an Indian experience. *BioMed research international*. 2016;2016.
27. Pati S, Swain S, Metsemakers J, Knottnerus JA, van den Akker M. Pattern and severity of Multimorbidity among patients attending primary care settings in odisha, India. *PLoS ONE*. 2017;12(9):e0183966.
28. Cornell JE, Pugh JA, Williams JW Jr, Kazis L, Lee AF, Parchman ML, Zeber J, Pederson T, Montgomery KA, Noël PH. *Appl Multivar Res*. 2008;12(3):163–82. Multimorbidity clusters: clustering binary data from multimorbidity clusters: clustering binary data from a large administrative medical database.
29. Chauhan A, Parmar M, Rajesham JD, Shukla S, Sahoo KC, Chauhan S, Chitiboyina S, Sinha A, Srigana G, Gorla M, Pati S. Landscaping tuberculosis multimorbidity: findings from a cross-sectional study in India. *BMC Public Health*. 2024;24(1):453.
30. Nunes MC, Júnior MH, Diamantino AC, Gelape CL, Ferrari TC. Cardiac manifestations of parasitic diseases. *Heart*. 2017;103(9):651–8.
31. Sarker PC, Khandker HH, Sarker CR, Khatoon M. Clinico-laboratory profile of 45 filarial arthritis cases. *Mymensingh Med Journal: MMJ*. 2007;16(2 Suppl):S7–11.
32. Pati S, Bhattacharya S, Swain S. Prevalence and patterns of Multimorbidity among human immunodeficiency virus positive people in odisha, india: an exploratory study. *J Clin Diagn Research: JCDR*. 2017;11(6):LC10.
33. Chowdhury SR, Das DC, Sunna TC, Beyene J, Hossain A. Global and regional prevalence of Multimorbidity in the adult population in community settings: a systematic review and meta-analysis. *EClinicalMedicine*. 2023;57.
34. Nguyen H, Manolova G, Daskalopoulou C, Vitoratou S, Prince M, Prina AM. Prevalence of Multimorbidity in community settings: A systematic review and meta-analysis of observational studies. *J Comorbidity*. 2019;9:2235042X19870934.
35. Tazzeo C, Zucchelli A, Vetrano DL, Demurtas J, Smith L, Schoene D, Sanchez-Rodriguez D, Onder G, Balci C, Bonetti S, Grande G. Risk factors for Multimorbidity in adulthood: A systematic review. *Aging Res Reviews*. 2023 Aug;28:102039.
36. Varanasi R, Sinha A, Nayak D, Manchanda RK, Janardhanan R, Tandon S, Pati S. Prevalence and correlates of Multimorbidity among patients attending AYUSH primary care settings in Delhi-National capital region, India. *BMC Complement Med Ther*. 2023;23(1):429.
37. Feng X, Kelly M, Sarma H. The association between educational level and Multimorbidity among adults in Southeast asia: A systematic review. *PLoS ONE*. 2021;16(12):e0261584.
38. Álvarez-Gálvez J, Ortega-Martín E, Carretero-Bravo J, Pérez-Muñoz C, Suárez-Lledó V, Ramos-Fiol B. Social determinants of Multimorbidity patterns: A systematic review. *Front Public Health*. 2023;11:1081518.
39. Asiedu SO, Kwarteng A, Amewu EK, Kini P, Aglomasa BC, Forkuor JB. Financial burden impact quality of life among lymphatic filariasis patients. *BMC Public Health*. 2021;21:1–0.
40. Rajoo SS, Wee ZJ, Lee PS, Wong FY, Lee ES. A systematic review of the patterns of associative multimorbidity in Asia. *BioMed Research International*. 2021;2021.
41. Zhang X, Padhi A, Wei T, Xiong S, Yu J, Ye P, Tian W, Sun H, Peiris D, Praveen D, Tian M. Community prevalence and dyad disease pattern of Multimorbidity in China and india: a systematic review. *BMJ Global Health*. 2022;7(9):e008880.
42. Makovski TT, Schmitz S, Zeegers MP, Stranges S, van den Akker M. Multimorbidity and quality of life: systematic literature review and meta-analysis. *Aging Res Reviews*. 2019;53:100903.
43. Rahi M, Chaturvedi R, Das P, Sharma A. India can consider integration of three eliminable disease control programmes on malaria, lymphatic filariasis, and visceral leishmaniasis. *PLoS Pathog*. 2021;17(5):e1009492.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.