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Burden of cardiometabolic diseases and depression in a low-income, urban community in Pakistan: a cross-sectional survey

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Abstract

Background With the rising epidemic of cardiometabolic diseases (CMDs) in low- and middle-income countries, urban populations face unique challenges such as poor sanitation, environmental pollution, and limited access to healthcare. This study estimates the point prevalence of CMDs and associated risk factors in adults in Karachi, analyses CMD prevalence by sex, and explores the relationship between CMDs and depression.

Methods A door-to-door survey was conducted in a densely populated urban community within a 0.5 km radius of a primary health centre. A minimum of 1,480 families were required to estimate the prevalence of CMDs. Depression was screened using PHQ-2 and assessed with PHQ-9. Descriptive analyses summarized family-level sociodemographic data. Sex-specific differences in CMD-related risk factors were analysed using χ^2 and t-tests. Point prevalence and 95% confidence intervals (CIs) for CMDs were calculated. Bivariate analyses compared cardiometabolic risk factors, healthcare utilization, and mental health across CMD categories. Logistic regression assessed associations between CMDs, demographics, risk factors, and depression.

Results Of the 1,513 families that participated, 3051 adults were included in the analyses. In this stable community (60% residing for more than five years), there was high Urdu (91%) and English (76%) literacy. There was high cell phone ownership (90%) and internet use (81%).

Hypertension was the most prevalent CMD (34%). The likelihood of CMD increased with age, rising 49.39 times (95% CI: 30.21 – 80.74; p: < 0.001) higher in those 60 years and above than those aged 18–29. CMD prevalence was strongly associated with depression, compared to those with no CMDs, there were significantly higher odds of mild (OR: 1.89; 95% CI: 1.28 – 2.78; p: < 0.001) and moderate (OR: 2.21; 95%CI: 1.17 – 4.17; p: < 0.014) depression among participants with CMDs.

Median health expenditure was 14.2% (IQR: 11.4—26.7%) of monthly income, with increasing CMD burden linked to higher rates of delay in purchasing medications (p: < 0.001).

Conclusion This study highlights the significant burden of CMDs, multimorbidity, and depression in a low-income urban community in Pakistan. The findings suggest that a cardiometabolic multimorbidity (CMM) epidemic is emerging in urban Pakistan, emphasizing the need for integrated interventions addressing physical, mental, economic, and environmental factors in CMD management.

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Keywords Cardiometabolic diseases, Cardiometabolic multimorbidity, Depression, Urban community, Low-middle income country

Background

Cardiometabolic diseases (CMDs) are a growing epidemic in low- and middle-income countries, including Pakistan [1], where rapid urbanization and inadequate urban planning pose unique challenges. Karachi- the megacity of Pakistan, is facing drastic growth with mixed-use development leading to congested road networks, mobility barriers, unsafe parking spaces, resident-cum commercial spaces that all contribute to an unsafe environment [2]. In addition, poor sanitation and environmental pollution have led to the limitation of green spaces that hinder safe physical activity, further contributing to a rise in CMDs and their associated risk factors [3]. Adding to the problem is the lack of connectedness and a sense of community in cities leading to social isolation, which negatively affects health behaviours and increases poor outcomes [4]. There is an established bidirectional association between CMDs and mood disorders; with an increase in the onset and prevalence of CMDs in people with mood disorders [5], and a higher risk of developing CMDs in people suffering from depression and anxiety [6]. This growing burden of CMD and mood disorders in LMICs presents complex challenges for healthcare delivery, especially in urban populations where a fee-for-service model prevents access and continuity, making it more likely for patients to drop out of the care cascade.

While national-level data offer an overview of disease burden, there remains a significant gap in granular assessments among urban communities. This information is crucial for designing targeted interventions that effectively address the unique challenges of urban populations. To address this gap, Aga Khan University has established the Family Medicine Health Centre (FMHC) in a low-income urban community of Karachi. FMHC has adopted the Patient-Centred Medical Home model by integrating primary care with a community-based health information system that will monitor the effectiveness of the health initiatives at FMHC to enhance access, continuity, and quality care for this low-income, urban community [7].

We report the results of the cross-sectional survey of the community in FMHC's catchment area which will serve as the baseline assessment of the community's burden of disease. Specifically, our objectives were to estimate the point prevalence of cardiometabolic diseases and their risk factors amongst adults (18 years and older) and examine the sex-specific differences in the prevalence of CMDs. In addition, we examine the association between CMDs and depression.

Methodology

Study design and setting

This descriptive cross-sectional study was conducted within the catchment population of FMHC, located in Gulberg town (a sub-division in the District Central of Karachi city) [8]. This is a densely populated urban community, with a socioeconomically diverse population [9]. We defined the catchment population as families living within a 0.5 km perimeter (walking distance) from FMHC. The catchment area included partial or complete areas of nine "census circles" (the third tier of census marked by the Pakistan Bureau of Statistics) [9, 10], with an estimated population of 34,679 [11]. The research team counted 4,993 residential structures during field mapping. The details of mapping are described in supplementary Image 1.

To recruit a representative sample from the catchment area, we based our assumptions on the predicted burden of cardiometabolic multimorbidity at 15% from published studies [12–14]. Assuming a design effect (*deff = 1.5*), an average family size of 5 persons, and a 30% response rate, we required a minimum of 1,480 families to participate in the survey.

Between May 2022 and February 2024, data collectors completed a door-to-door survey of each census circle inviting families to participate in the survey. Recruitment continued until all housing structures within a particular circle were approached. All families who showed interest in participation were included in the survey. Supplementary Table 1 (additional file) shows population size and sample coverage from the nine census circles within the catchment area.

To abide by cultural norms, female participants were recruited by female data collectors in a private setting within their houses. All participants were interviewed separately. The data was captured directly on secure Android tablets using REDCap®.

Health assessment survey

We developed a structured questionnaire to capture family and participant-level information, using elements from standardized surveys including the Pakistan Demographic and Health Survey (PDHS), and the Demographic and Health Survey (DHS) [15, 16]. The survey was in Urdu (the national language). Refer to Supplement Table 2 showing the study questionnaire. Family-level data included demographics, family income, and family's health care expenditure. Participant-level data included sociodemographic information, anthropometric

and blood pressure measurements, self-reported cardiometabolic disease/s, medication adherence, and depression screening and assessment using PHQ-2 and PHQ-9 respectively [17–19].

Operational terms

Families in HAS: We used the standard definition of a family as "a person or group of related and unrelated persons who live together in the same dwelling unit/s or in connected premises, who acknowledge one adult member as head of the family, and who have common arrangements for cooking and eating" [15].
Cardiometabolic diseases: self-reported presence of hypertension, diabetes mellitus, dyslipidemia, stroke, and ischemic heart disease. Participants who did not have a diagnosis of hypertension, but had elevated blood pressures (≥ 140/90 mmHg) were reassessed. A new diagnosis of hypertension was given if blood pressure on two repeated measurements was more than 140/90 mmHg [20].
Cardiometabolic multimorbidity: Cardiometabolic multimorbidity (CMM) was defined as "participants having two or more cardiometabolic diseases" [21, 22].
Depression: we used PHQ–2 (Patient Health Questionnaire- 2) to screen for depression and PHQ-9 for diagnosis and severity of depression. A positive screen was defined as answering "Yes" to either of the two questions on PHQ-2 [23]. Participants with a score of ≥ 5 on PHQ-9 were diagnosed with depression [18].

Participant eligibility and recruitment

All members of a household could participate in the study. Initial consent was obtained from the head of the household, followed by individual family members. Only age and sex were recorded for family members who refused to participate. If family members were absent during the initial visit, two more attempts were made at a time convenient to them.

Ethical considerations

The survey was approved by the institutional Ethical Review Committee (2022–6723-20,985). We received permission from the district health authorities. In addition, for neighbourhoods that had local administrative committees, permission was obtained from them before starting the survey. All participants provided written informed consent and received a signed copy for their records. In situations where the eligible participants were illiterate, the health workers read consent for them in the local language (Urdu), and then the head of the family as their appropriate representative signed the informed consent on their behalf. Unique study identifiers were given to each family and sub-identifiers were assigned to each participating family member. In situations where participants' blood pressure readings were greater than optimal ranges, those with new diagnoses of hypertension, and those with PHQ-9 depression scores ≥ 10 indicating moderate depression, were offered medical consultations at FMHC.

Statistical analysis

Descriptive analyses were performed to summarize family-level sociodemographic factors. Categorical variables are presented as frequencies (n) and proportions (%), while continuous variables are reported as mean ± standard deviation (SD) for normally distributed data and median with interquartile range (IQR) for skewed data.

At the participant level, sex-specific differences in sociodemographic characteristics and cardiometabolic risk factors were assessed using the χ^2 test for categorical variables and the two-sample t-test for continuous variables. The point prevalence and 95% confidence intervals (CIs) for each cardiometabolic disease were calculated. Depression screening using the PHQ-2 was dichotomized (yes/no), while depression diagnosis using PHQ-9 was categorized as no depression (0–4) and mild to severe (≥ 5). Depression screening using PHQ-2 was completed for 2,939 participants (96%), and PHQ-9 diagnostic assessment was available for 2,032 participants (66%).

A count variable for the number of co-existing cardiometabolic diseases [ranging from 0 (no disease) to 4 (maximum)] was created. Bivariate analyses were conducted to compare the distribution of cardiometabolic risk factors, healthcare utilization, and mental health across the number of CMDs.

Binary logistic regression was used to examine the associations between the presence of any CMD with demographics, cardiometabolic risk factors, and depression. The results are reported as odds ratios with 95%CI. Covariates for the models were selected based on clinical relevance, established associations in the literature, or statistical significance in univariate analyses at $p: < 0.2$. Separate models were created for depression screening (PHQ-2) and depression severity (PHQ-9).

All analyses were performed using Stata/SE 18 (StataCorp, College Station, TX, USA), and used a two-tailed value of $p: < 0.05$ for statistical significance.

Results

We approached 4933 families, of which 1513 (30%) agreed to participate. In these families, 4,656 of 6,180 (75%) family members consented to participate; of which 3,051 were adults (≥ 18 years). Participation varied

among census circles from 3.63 to 59% (Additional file supplementary Table 1).

Table 1 shows the characteristics of the participating families. The average family size was 4.3 ± 2.0 members. Almost 60% of families had resided in their current dwellings for over five years, indicating residential stability. Most families (82%) belonged to a low socioeconomic status with an average income of < $2 per person per day. The median proportion of health expenditure was 14.2% (IQR:11.4 – 26.7%) of the monthly income with a wide range (min 1.6%—max 200%).

Sex-specific differences in the demographic and cardiometabolic risk factors are presented in Table 2. Male participants were older than female participants (44 vs 42.5 years; *p*: 0.0104). Despite a low socio-economic status, 83% of participants reported studying beyond high school. More men were employed outside the house (64%); whereas 76% of women were homemakers. Literacy rates were high, with 91% of participants reporting the ability to read and write in Urdu (the national language) and 76% able to read and write in English. There was widespread digital access; with 90% participants owning a cell phone and 81% reporting internet use within the past year. However, internet use was higher among men than women (84% vs. 79%; *p*: < 0.001).

Of the cardiometabolic risk factors, approximately 7% reported a history of smoking, and 10% reported using smokeless tobacco. Approximately 37% of the adult participants were obese and 77% had central obesity; both showing significant preponderance in women.

Table 1 Characteristics of families in health assessment survey

Characteristics N: 1,513	n (%)
Average family size mean ± SD	4.3 ± 2.0
Years at residence	
< 1 year	187 (12)
1—5 years	404 (27)
5.1—10 years	232 (15)
> 10 years	690 (45)
Household income/month (US$)*	
Median (IQR 25th-75th %ile)	134 (62.5—223.2)
Min–max	18—536
Socioeconomic Status*	
Low-income families (< $2/person/day)	1,027 (82)
Low-middle income families ($2–4/person/day)	197 (16)
Middle-income families (> $4–10/person/day)	28 (2.2)
Proportion of household income used on health/ month (% of monthly income)	
Median (IQR 25th-75th %ile)	14.2 (11.4—26.7)
Min–max	(1.6—200)

* conversion rate (1US$ = 280 PKR)

Table 3 presents the point prevalence of CMDs, CMM, and depression in men and women. Of the CMDs, hypertension was the most prevalent (34%); of which 319 (30%) were new cases diagnosed during the survey. Overall, 454 (15%) participants had CMM, with no significant difference between men and women. Depression screening was positive for 517 (17%) participants and 317 (15%) were assessed to have depression on PHQ-9; with a significantly higher prevalence in women than men (20% vs. 11%; *p*: < 0.001).

Table 4 examines the distribution of demographic, cardiometabolic risk factors, depression, and healthcare utilization across the number of CMDs. We find that CMD prevalence increases with increasing age, from 16% among participants aged 30–39 years to 40% among those aged 40–49 years, 64% among those 50–59 years, to 82% among those who were 60 years and older. In addition, there was a strong association of increasing CMD prevalence with both obesity and central obesity (as defined by elevated waist circumference).

As expected, there was an increase in both inpatient and outpatient healthcare utilization with an increasing number of CMDs. More concerning was that the proportion of participants who delayed buying medications to save money increased with an increasing number of CMDs, showing the impact of the poor health infrastructure on chronic disease management in low-income families.

Figure 1 shows the proportion of CMDs and depression by sex and age groups. We see an alarming prevalence of hypertension even in younger age groups (12% in the 30–39 years age group) which increases to 73% in those older than 60 years. Interestingly, we also see an increase in depression across the age groups (ranging from 6.3% in the 30–39-years group vs. 17.4% in the > 60 years group).

The association between the presence of CMDs and known sociodemographic and cardiovascular risk factors including depression screening and diagnosis is shown in Table 5. We found that compared to women, men had higher odds of having CMD (OR: 1.36; 95% CI: 1.09—1.69; *p*: < 0.001). The odds of having CMD increased with each decade of life. Compared to 18–29-year-olds, participants in the 30—39-year-old group were 2.13 times (95% CI: 1.49 – 3.80; *p*: < 0.002) more likely to have CMD and the odds were 49.39 times (95% CI: 30.21 – 80.74; *p*: < 0.001) higher in those 60 years and older.

There was a significant association of CMD with feeling overwhelmed with health and depression. A small percentage of participants with no CMD reported feeling overwhelmed due to their health (7%) and were diagnosed with depression (9%). However, we found that the subjective feeling of being overwhelmed with health increased significantly as the number of CMDs increased; and a similar increase was seen both in screening and diagnosis of depression (Table 4). In multivariate

Table 2 Sex-specific differences in demographic and cardiometabolic risk factors among participants

Characteristics	Total 3,051	Male 1,183	Female 1,868	*p-value*
Age, years mean ± SD	43.1 ± 16	44 ± 17	42.5 ± 15	0.0104*
Marital Status				
Single	687 (23)	347 (29)	340 (18)	< 0.010^
Married	2,051 (67)	793 (67)	1,258 (67)	
Divorced/ Widowed/ Separated	313 (10)	43 (4)	270 (15)	
Level of education				
No education	180 (6)	60 (5)	120 (6)	< 0.01^
Matriculation (class 1–10)	809 (26)	270 (23)	539 (29)	
College (2- 4- year program)	1,023 (34)	376 (32)	647 (35)	
University graduate	964 (31)	437 (37)	527 (28)	
Informal or skilled education	11 (0.3)	5 (0.4)	6 (0.3)	
Did not answer	64 (3)	35 (3)	29 (2)	
Employment Status				
Employed	966 (32)	754 (64)	212 (11)	< 0.01^
Homemaker	1,423 (47)	2 (0.1)	1,421 (76)	
Retired	172 (6)	147 (13)	25 (1.3)	
Student	315 (10)	137 (11)	178 (10)	
Unemployed	165 (5)	141 (12)	24 (1.3)	
Did not answer	10 (0.3)	2 (0.1)	8 (0.4)	
Literacy status				
Read and write in Urdu	2,788 (91)	1,099 (93)	1,689 (90)	0.017^
Read and write in English	2,318 (76)	954 (81)	1,364 (73)	< 0.01^
Digital Access				
Own a cellphone	2,739 (90)	1,126 (95)	1,613 (86)	< 0.01^
Internet use in the last 12 months	2,471 (81)	992 (84)	1,479 (79)	0.001^
Tobacco use				
Smoke cigarettes/ e-cigarettes	216 (7)	214 (18)	2 (0.1)	< 0.01^
Use smokeless tobacco	301 (10)	226 (19)	75 (4)	< 0.01*
Cardiometabolic Risk Factors				
Average Systolic BP (mm/Hg)++	146 ± 14	146 ± 13	147 ± 14	0.82*
Average Diastolic BP (mm/Hg)++	88 ± 10	87 ± 11	88 ± 9.4	0.39*
BMI (Kg/m2) mean ± SD	26.0 ± 4.8	24.8 ± 4.8	26.8 ± 6.3	< 0.01*
Obese, n (%) (BMI > = 27.5 kg/m2)	1,126 (37)	327 (27)	799 (43)	< 0.01*
Waist Circumference (cm) mean ± SD	95 ± 12	92 ± 11	96 ± 13	< 0.01*
Elevated Waist Circumference, n (%) (Male ≥ 90 cm; Female ≥ 80 cm)	2,354 (77)	685 (58)	1,669 (89)	< 0.01^

* Two sample t-test

^ χ^2 test of statistics

++ An average of 2nd and 3rd blood pressure readings is presented when the first reading was > 130/90 mmHg

regression, compared to people with no CMDs, those with CMDs were at higher odds of being overwhelmed with health conditions (OR 5.68; 95% CI: 3.80 – 8.48; *p*: < 0.001) and had higher odds of mild (OR: 1.89; 95% CI: 1.28 – 2.78; *p*:0.001) and moderate (OR: 2.21; 95%CI: 1.17 – 4.17; *p*: < 0.014) depression.

Discussion

Our study provides a comprehensive picture of the cardiometabolic disease burden and depression in a low-income, urban community in Pakistan. We identified a substantial burden of cardiometabolic diseases, cardiometabolic multimorbidity, and associated risk

Table 3 Prevalence of cardiometabolic diseases and depression among participants

Diseases	Total 3,051		Male 1,183		Female 1,868		*p-value*^
	n (%)	95%CI	n (%)	95%CI	n (%)	95%CI	
Hypertension	1,031 (34)	32.11—35.50	396 (33)	30.78—36.24	635 (34)	31.84—36.19	0.768
Diabetes Mellitus	411 (13)	12.27—14.73	161 (13)	11.70—15.69	250 (13)	11.87—15.01	0.858
Dyslipidemia	192 (6)	5.45—7.21	60 (5)	3.89—6.48	132 (7)	5.94—8.32	0.083
Stroke	29 (1)	0.63—1.36	16 (1.4)	0.77—2.18	13 (0.7)	0.37—1.18	0.069
Heart Attack	117 (4)	3.18—4.57	66 (6)	4.34—7.04	51 (3)	4.34—7.04	< 0.001
Cardiometabolic multimorbidity *(> = 2 cardiometabolic diseases)*	454 (15)	13.63—16.19	177 (15)	12.97—17.12	277 (15)	13.24—16.52	0.920
Depression screening PHQ-2 n:2,939 (96%)#	517 (17)	16.23—19.01	149 (13)	11.14—15.14	368 (20)	18.63—22.41	< 0.001
Depression PHQ-9^^ n:2,032 (66%)#	317 (15)	14.04—17.25	90 (11)	8.766—13.09	227 (20)	16.76—21.28	< 0.001

^χ^2 test of independence

missing data

^^ PHQ-9 scores reporting (mild-severe depression)

factors even among younger individuals. Hypertension remains the most common CMD, as seen in other population-based studies in Pakistan [24, 25]. More concerning was that 30% of people with hypertension were unaware of their diagnosis. This lack of awareness along with the alarming levels of obesity, sedentary lifestyles, and high salt intake are all contributing to the premature morbidity and mortality seen due to cardiovascular diseases in Pakistan [25]. Our reported prevalence of diabetes is lower compared to the 26.3% reported by the recent National Diabetes Survey of Pakistan (NDSP) [26]. As we did not test people for diabetes, it is possible that we may have missed some who had undiagnosed diabetes. We also found a high prevalence of CMM (15%) in both men and women. While CMM is the norm in aging populations, LMICs are seeing an increased burden in younger people [27]. Poor Lifestyle choices including smoking; poor diet quality; inadequate physical activity; and sleep quality along with lack of screening for CVD risk factors and obesity are the primary contributors to the higher burden of CMD in the younger population [28]. Understanding the local, context-specific burdens and risk factors of CMM and determining mechanisms to best address them will have to become a national and global priority.

We found a very high prevalence of both obesity and central obesity, with an increasing prevalence with the number of CMDs. The Pakistan Panel Household Survey has reported a higher likelihood of overweight/obesity in people living in urban areas (OR: 1.23; 95% CI: 1.12–1.35) as compared to their rural counterparts [29]. Exposure to green spaces can positively impact cardiometabolic health by reducing air and noise pollution, restoring mental capacities, and promoting physical activity and social connectedness. Lack of access to green spaces adds to the risk burden for people living in poorly planned, densely populated urban communities. Our study adds to the importance of considering the lived environment in strategies to decrease CMD burden.

We found a strong association between CMDs and mental health. A higher proportion of participants reported feeling overwhelmed as the number of CMDs increased; and a direct association was found between CMDs and depression. In addition, among the 17% of adults who screened positive for depression, the odds of having cardiometabolic conditions were 78% higher compared to those who did not screen positive. Our study highlights the complex interplay between physical and mental health, with CMDs often co-occurring with mood disorders [30, 31]. These findings are similar to the UK Biobank study with 460,000 participants [32], where depression increased the risk of developing diabetes (HR, 95% CI: 1.43, 1.37–1.50), stroke (1.28, 95% CI:1.20–1.38), and coronary heart disease (1.35, 95% CI: 1.31–1.40). Other studies have shown similar bidirectional associations [33]. Co-occurrence of cardiometabolic diseases and depression is associated with poorer disease control, reduced medication adherence, increased risk of complications, and higher mortality [34]. Our study

Table 4 Distribution of demographic, risk factors, and healthcare utilization across number of cardiometabolic diseases

Factors	No cardiometabolic diseases n:1,871	One cardiometabolic disease n:726	Two cardiometabolic diseases n:325	Three or more cardiometabolic diseases n:129	*p-value*
Sex					
Male	718 (39)	288 (40)	129 (40)	48 (37)	0.892
Female	1,153 (61)	438 (60)	196 (60)	81 (63)	
Age (y)					
18—29	702 (37)	33 (5)	2 (1)	1 (1)	< 0.001
30—39	516 (27)	82 (11)	10 (3)	4 (3)	
40—49	365 (20)	183 (25)	53 (16)	12 (9)	
50—59	185 (10)	192 (26)	103 (32)	36 (28)	
60 and above	103 (6)	236 (33)	157 (48)	76 (59)	
Cardiometabolic diseases[a]					
Hypertension[b]	-	596 (82)	307 (94)	128 (99)	< 0.001
Diabetes Mellitus	-	84 (11)	212 (65)	115 (89)	< 0.001
Dyslipidaemia	-	23 (3)	75 (23)	94 (73)	< 0.001
Heart Attack	-	22 (3)	44 (13)	51 (39)	< 0.001
Stroke	-	1 (0.1)	12 (3)	16 (12)	< 0.001
Early CVD in first-degree relatives [c]					
% Yes	14 (0.7)	13 (2)	6 (2)	7 (5)	< 0.001
Elevated waist circumference (cm)					
% Yes	1,331 (71)	613 (84)	289 (89)	121 (98)	< 0.001
BMI (Kg/m^2)					
< 18.5	200 (11)	32 (5)	7 (2)	3 (2)	< 0.001
18.5—23.0	485 (26)	127 (18)	49 (15)	15 (12)	
23.0—27.5	623 (33)	244 (33)	99 (31)	38 (29)	
> = 27.5	561 (30)	323 (44)	169 (52)	73 (57)	
Tobacco use[d]					
% Yes	256 (13)	136 (19)	46 (14)	16 (12)	0.010
Felt overwhelmed because of health					
Always	40 (2)	84 (11)	49 (15)	46 (35)	< 0.001
Sometimes	81 (5)	158 (22)	116 (36)	38 (30)	
Never	1,750 (93)	484 (67)	160 (49)	45 (35)	
PHQ-2[e] (n:2,939)					
Screen + ve Depression	227 (12)	171 (23)	80 (25)	39 (31)	< 0.001
PHQ-9[e] (n:2,032)					
Depression[f]	106 (9)	120 (24)	58 (25)	33 (38)	< 0.001
Delayed buying medications to save money					
% Yes	-	66 (9)	43 (13)	20 (15)	< 0.001
In-patient admission					
% Yes	81 (4)	44 (6)	25 (7)	19 (15)	< 0.001
Outpatient care					
% Yes	442 (23)	236 (32)	141 (43)	66 (51)	< 0.001

Reporting column percentages

[a] Chronic diseases are presented as combinations

[b] Include those with a medical history of HTN and new cases of HTN

[c] early stroke or heart attack (men < 55 years and women < 65 years)

[d] Present use of cigarettes and smokeless tobacco

[e] missing data

[f] PHQ-9 scores (reporting mild-severe depression)

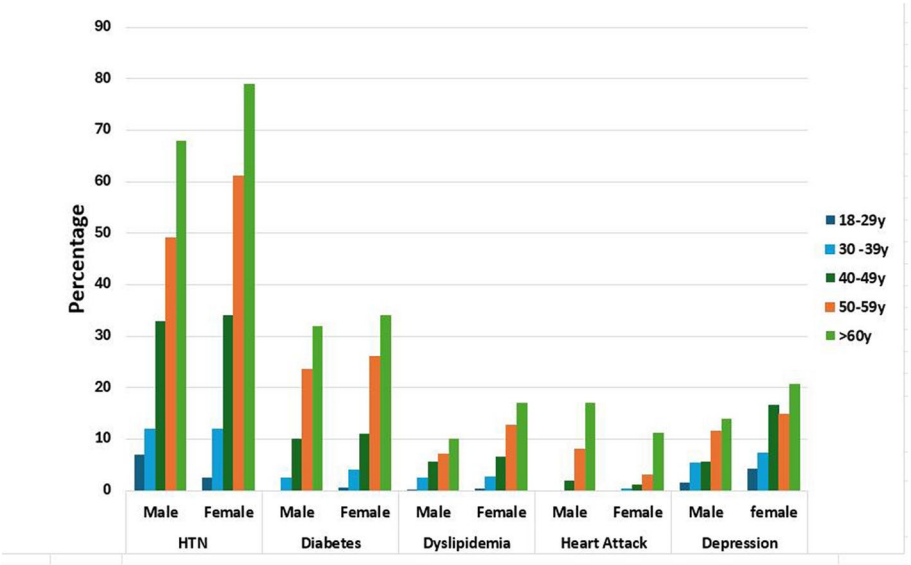

Fig. 1 Bargraph showing age and sex-specific cardiometabolic disease (CMDs) and depression burden

adds to these findings in the South Asian population and highlights the importance of screening not only for other CMDs but also for mental health disorders when a chronic disease is first diagnosed.

We share the financial impact of CMDs on families living in urban settings. While the median health expenditure was 14.2% (IQR:11.4—26.7%) of the monthly income, there were extremes of up to 200%. A higher proportion of participants delayed purchasing medications as the disease burden increased. In the absence of government-funded primary healthcare in urban communities, families have to rely on self-payment for medical services and medications [35, 36]. The inability to buy medications and sustain care contributes significantly to the poor health outcomes [37, 38], and sometimes catastrophic economic impact of CMDs on these low-income families.

Our study has limitations. The reliance on self-reported cardiometabolic diseases without confirmatory laboratory data may introduce some degree of misclassification. While we were able to identify people with hypertension and depression through the study, we may have missed people with undiagnosed diabetes.

Additionally, the cross-sectional study design precludes establishing causality between risk factors and, cardiometabolic diseases and depression. Finally, while we were able to enrol enough households to achieve the sample size, we found lower participation in census circles with more affluent households (as shown in Supplementary Table 1). While this may create some misrepresentation in the data, we were able to capture the more socially vulnerable households. Other studies have found similar challenges in engaging affluent households in urban areas due to participants' security concerns [39].

Despite these limitations, this study addresses the gap in local research by evaluating the burden of CMD and CMM, and the complex interaction between the mental, physical, and socioeconomic impacts in an urban community. The study takes a comprehensive approach to capturing socio-economic factors at the family level; enhancing our understanding of the context in which CMM develops and persists, enabling the design of tailored interventions. The coexistence of CMDs and depression further underscores the need for integrated programs that can address social isolation prevalent in urban communities while being culturally sensitive and financially accessible. Longitudinal studies will further improve our understanding of the social and economic impact of CMDs. Additionally, the study identifies a community with high literacy and access to digital technology presenting an opportunity for mobile health (m-Health) initiatives. By leveraging the growing trust in the community, the research team aims to implement interventions that empower individuals to manage their health more effectively.

Conclusion

This study presents data on the significant burden of cardiometabolic diseases, cardiometabolic multimorbidity, and depression in a low-income urban community in Karachi, Pakistan. These results suggest that urban Pakistan is facing an emerging CMM epidemic, likely driven

Table 5 Association between cardiometabolic disease(s), sociodemographic and cardiovascular risk factors, and depression

Variables	PHQ-2			PHQ-9		
	aOR	95%CI	*p-value*	aOR	95%CI	*p-value*
Sex						
Female	**1.0**			**1.0**		
Male	1.36	1.09—1.69	0.005	1.62	1.25—2.10	< 0.001
Age, years (category)						
18–29	**1.0**			**1.0**		
30–39	2.13	1.49—3.80	< 0.002	1.89	1.18—3.52	0.023
40–49	7.13	4.49—11.30	< 0.001	6.50	3.84—11.01	< 0.001
50–59	17.83	11.14—28.55	< 0.001	16.74	9.72—28.81	< 0.001
≥ 60	49.39	30.21—80.74	< 0.001	50.86	28.73—90.03	< 0.001
Marital Status						
Single	**1.0**			**1.0**		
Married	1.12	0.76—1.63	0.557	1.01	0.65—1.56	0.960
Others *(widowed, divorced, separated)*	1.33	0.81—2.14	0.258	1.15	0.64—2.07	0.652
BMI (Kg/m2)						
Underweight (BMI < 18.5)	**1.0**			**1.0**		
Normal (BMI 18.5 – 22.99)	1.83	1.05—3.18	0.046	1.72	0.87—3.41	0.115
Overweight (BMI 23 – 77.49)	2.91	1.71—4.96	< 0.001	2.71	1.40—5.25	0.003
Obese (BMI ≥ 27.5)	4.55	2.67—7.76	< 0.001	3.81	1.97—7.37	< 0.001
Delay buying medications to save money						
No	**1.0**			**1.0**		
Yes	2.05	1.21—3.47	< 0.007	2.55	1.04—6.24	0.039
Feeling overwhelmed because of health conditions						
Never	**1.0**			**1.0**		
Sometimes/Always	6.96	5.15—9.41	< 0.001	5.68	3.80—8.48	< 0.001
Depression	**PHQ-2 screening**			**PHQ-9 diagnosis**		
Screen -ve	**1.0**					
Screen + ve	1.06	0.81—1.38	0.66			
Normal				**1.0**		
Mild depression				1.89	1.28—2.78	0.001
Moderate-severe depression				2.21	1.17—4.17	0.014

by shifts in dietary patterns and lifestyle behaviors linked to rapid urbanization. Additionally, this study emphasizes the need for comprehensive interventions that not only focus on the physical but also the mental, economic, and environmental aspects in which these conditions develop. Addressing these issues can help improve health outcomes and reduce the burden of cardiometabolic diseases in vulnerable populations.

Abbreviations

CMDs Cardiometabolic Diseases
CMM Cardiometabolic Multimorbidity
FMHC Family Medicine Health Centre
PCMH Patient-Centred Medical Home
PDHS Pakistan Demographic & Health Survey
DHS Demographic & Health Survey

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions
UIK: conception, design, analysis, interpretation, finalized manuscript. SS: design, draft manuscript. AQ: data integrity, analysis, interpretation, draft of manuscript. SV: design, analysis, interpretation, review of manuscript. ATM: design, analysis, interpretation, review of manuscript. SSV: interpretation, review of manuscript JWR: conception, design, interpretation, and review of manuscript. YN: data acquisition, draft of manuscript.

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Data availability
The data collected and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval was obtained from the Aga Khan University Ethical Review Committee (#2022-6723-20985). Written informed consent was obtained from participants before the commencement of the study and, as per ERC requirement, a signed copy of the consent form was also provided to the participants for their record. In situations where the eligible participants were illiterate, the health workers read consent for them in the local language (Urdu), and then the head of the family as their appropriate representative signed the informed consent on their behalf. All study procedures were performed in accordance with the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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