

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

A social network analysis of psychological morbidity in an urban slum of Bangladesh: a cross-sectional study based on a community census

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-020180
Article Type:	Research
Date Submitted by the Author:	21-Oct-2017
Complete List of Authors:	Rabbani, Atonu; Dhaka University, Department of Economics; BRAC University James P Grant School of Public Health, Biju, Nabila; BRAC University James P Grant School of Public Health, Rizwan, Ashfique; BRAC University James P Grant School of Public Health, Sarker, M; BRAC University James P Grant School of Public Health, ; Institute of Public Health
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Global health, Sociology
Keywords:	MENTAL HEALTH, PUBLIC HEALTH, Social Network, Social Determinants

SCHOLARONE™
Manuscripts

1
2
3 1 **A social network analysis of psychological morbidity in an urban slum of Bangladesh: a**
4
5 2 **cross-sectional study based on a community census**
6
7

8 3 Atonu Rabbani^{a,*}, Nabila Rahman Biju^b, Ashfique Rizwan^c, Malabika Sarker^d
9
10

11 4
12 5 ^aDepartment of Economics, University of Dhaka, Dhaka 1000, Bangladesh & BRAC School of
13 6 Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin Ahmed Sharani,
14 7 Mohakhali, Dhaka-1212, Bangladesh. Email: atonu.rabbani@gmail.com,
15 8 atonu.rabbani@econdu.ac.bd
16 8

17 9 ^bBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
18 10 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh. Email: nabila.rahman@bracu.ac.bd

19 11 ^cBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
20 12 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh. Email: ashfique.rizwan@bracu.ac.bd

21 13 ^dBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
22 14 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh & Institute of Public Health, Im
23 15 Neuenheimer Feld 130.3, Marsilius Arkaden - 6. Stock, 69120 Heidelberg, Germany. Email:
24 16 malabika@bracu.ac.bd
25 16
26 17
27 17
28 18
29 18
30 18
31 18
32 18
33 18

34 19 ***Corresponding Author:**
35
36

37 20 Atonu Rabbani
38 21 Associate Professor
39 22 Department of Economics
40 23 University of Dhaka
41 24 Dhaka 1000, Bangladesh
42 25 Email: atonu.rabbani@gmail.com
43 26 Phone: +8801730441787
44 26
45 27
46
47

48 28 **Word Count:**
49

50 29 Paper – 3,513 (2,940 without tables and figure placement texts)
51
52

53 30 Abstract – 213
54
55
56
57
58
59
60

Abstract

Objectives To test whether social ties play any roles in mitigating depression and anxiety, as well as fostering mental health among young men living in a poor urban community.

Setting A cohort of all young men living in an urban slum in Dhaka, the capital of Bangladesh.

Participants All 18 to 29 years old men (N = 824) living in the low income urban community at the time of the survey.

Primary and secondary outcome measures Unspecified psychological morbidity measured by Generalized Health Questionnaire (GHQ 12).

Results The GHQ scores (mean = 9.2, SD = 4.9) suggest significant psychological morbidity among the respondents. However, each additional friend is associated with 0.063 SD lower GHQ score (95% CI -0.106 to -0.021). Between centrality measuring relative importance of the respondent within his social network is also associated with 0.103 SD lower GHQ score (95% CI -0.155 to -0.051), as are other measures of social network ties. Among other factors, married respondents and recent migrants also report better mental health status.

Conclusions Our results underscore the importance of social connection in providing buffer against stress and anxiety through psychosocial support from one's peer in a resource constraint urban setting. Our findings also suggest incorporating social network and ties in designing mental health policies and interventions.

Keywords: Mental health outcomes; social network; urban young men; regression analyses.

1 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 2 • Our analyses take advantage of a census of young men in a resource constraint low-income
3 urban community in Bangladesh.
- 4 • The measurement of social network is based on roster-based approach where friendship
5 connections for all possible pairs of respondents are carefully assessed and validated.
- 6 • We take advantage of a locally adopted GHQ-12 to assess unspecified mental health
7 outcomes along with detailed socioeconomic characteristics of our respondents.
- 8 • Our study underscores the importance of social connection within a community in
9 determining mental health outcomes for urban young men in developing countries.
- 10 • Cross sectional data limits causal interpretations of the otherwise robust relationships and our
11 measure of social network captures limited community ties through friendship relations only.

1 INTRODUCTION

2 Mental illness and disorders generally refer to “abnormal thoughts, perceptions, emotions,
3 behaviour and relationships with others.”[1] Mental illness contributes about 7.1 percent to
4 global disease burden and the cost of mental disorders such as depression can be enormous.[2,3]
5 Over lifetime, mental disorder can adversely affect one-third of the global population.[4] As of
6 2010, close to nine hundred million people were estimated to suffer from certain mental health
7 issues including depression, anxiety and substance abuse.[5] The burden of mental health is also
8 likely to increase with growing urbanization in the developing countries.[6] The poor
9 neighborhoods and low-income communities can potentially offer more stressful environments
10 for the urban citizens.[7] Hence, one can potentially infer a larger share of the global mental
11 health burden will be borne by the lower income population living in challenging environments
12 in the newly urbanized developing countries. This will further be compounded by social stigma
13 and general misinformation associated with mental health symptoms and resulting low
14 psychosocial care seeking in the developing countries.[8]

15 Social capital can be multifaceted and the definitions vary in the literature as they aim to
16 capture the different aspects of social engagements for an individual.[9] Social capital
17 encompasses civic engagement, trust, reciprocity and certain norms. Moreover, it can both be a
18 structural feature of the community or a group and owned by individual to rely and exploit to
19 command over resources to ensure his or her wellbeing.[10,11] Horizontal nature of the ties, for
20 example, friendship network and community embeddedness are considered a defining feature of
21 one’s social capital and prior literature typically associate resulting social capital with socially
22 desirable health outcomes.[12]

1
2
3 1 There is a growing consensus that the quality of social ties and deeper social embeddedness
4
5 2 are important determinants of mental health.[13,14,15] Lack of social ties has been found to be a
6
7 3 risk factor for a number of mental health indicators.[16,17,18,19] Through providing attachment
8
9 4 and buffer, social network and ties can have both extrinsic and intrinsic values for an individual's
10
11 5 mental or psychological wellbeing.[20,21] Prior studies have shown the positive roles social
12
13 6 connection can play in lowering depressive episodes.[19,22] Depressive symptoms are also less
14
15 7 likely to manifest themselves for people who are more central within the group they belong to.[3]
16
17 8 Mental state of mind, like happiness, can also proliferate for people with social networks that are
18
19 9 closer in terms of geographic distance.[18]

20
21
22
23
24 10 In the context of Bangladesh, social network has been found to contribute towards health
25
26 11 service delivery in both rural and urban areas.[23,24] However, we have limited information on
27
28 12 how social ties and network properties can determine mental health outcomes in urban
29
30 13 Bangladesh and similar other low-income contexts. Social network has been found to have
31
32 14 strong association with positive mental health outcomes. However, these studies have taken
33
34 15 place mostly in the developed countries by taking advantage of large, often longitudinal, cohort
35
36 16 studies and population level data.[3,18,19,22] We intend to contribute to the growing literature
37
38 17 on social network as a determinant of mental health by exploiting a community level census of
39
40 18 young men in a slum of Dhaka.

41 42 43 44 45 46 47 19 **METHOD**

48 49 50 20 **Study Design**

51
52 21 We follow a cross-sectional study design based on individual respondents from a census of
53
54 22 young men living in an urban slum at the time of the survey (N = 824). Census allows us to

1 enumerate friendship ties along with directions between any two respondents among possible
2 339,076 ties. We also collect mental health outcome measures along with detailed socio-
3 economic characteristics of the respondents.

4 **Study Setting**

5 We have carried out our study in a particular but otherwise typical urban community in
6 Dhaka, namely *Vashantek*. The entire *Vashantek* slum is geographically divided into four
7 subdivisions with a total population of around 31 thousand or about 5.5 thousand households.
8 We choose to work in a particular subdivision and carry out a census of all men between the age
9 of 18 and 29 years. We collect baseline information on a number of socioeconomic variables and
10 detailed social network information for all the targeted respondents. The site and the setting meet
11 the necessary criteria for usual social network analyses.[25]

12 **Sample and sampling technique**

13 We collect information for all men between the ages of 18 and 29 in our targeted site.
14 Initially we list all the households in the study community with men who fit the age criteria. We
15 ask each household if it has an 18-29 year old man living in the household. Then we follow up
16 with their full names, contact information and their availability for a more detailed survey. From
17 the household list, we select a total of 942 potential respondents. After thorough training of the
18 data collectors and questionnaire pretesting, we send our data collectors to collect information on
19 demographic, economic, sexual practice and friendship related information using a structured
20 questionnaire. Some of the respondents moved out of the slum between the initial household
21 listing and the follow up survey. We also find households with a potential respondent living
22 outside the community but previously listed as a household member. The final cohort consists of

1 824 young men of 18 to 29 years of age living in our study area. We have carried out all analyses
2 on this sample.

3 **Measures of Mental Wellbeing**

4 We use the 12-question version of the General Health Questionnaire (GHQ-12) to assess the
5 mental wellbeing of individuals. It is an often-used survey based tool to measure the population
6 morbidity of non-psychotic and minor psychiatric disorders. GHQ-12 has been implemented and
7 validated widely in different contexts in both developed and developing countries, including
8 Bangladesh.[26,27] Due to its precise and concise nature and validity in the context of
9 Bangladesh, we consider this tool to be appropriate for our study to assess any non-specific
10 psychiatric morbidity among the respondents.[28] We estimate *Cronbach's α* , and a value of
11 0.83 suggests high internal consistency. We further carry out exploratory factor analysis and high
12 individual variance for each factor suggests high reliability of the score in our sample.

13 **Social Network Analysis (SNA) Parameters**

14 For the social network analysis, we ask each respondent to name the close friend(s) within
15 the community and where they live (particular landmark/household identifier within the slum).
16 After confirming the proper identification of all the close friends mentioned by the respondents,
17 we construct a 824×824 square *sociomatrix* showing direct friendship ties with value 1 or 0.[29]
18 We then use network analysis software *Pajek* to analyze this dataset. We estimate different social
19 network parameters for each of our respondents such as different measures of embeddedness,
20 and centrality of each respondent within the friendship network. These measures capture richer
21 aspects of social network of the respondents.[20,30] For robustness check and sensitivity
22 analyses, we use non-linear versions of some of our centrality measures, due to the
23 overrepresentation of zeros in our sample, which indicates absence of any ties between

1 individuals.[19] We also estimate some additional measures of the nature of the social network at
2 individual levels to carry out further sensitivity analyses (see Appendix).

3 **Socioeconomic Characteristics**

4 Given the observational nature of our study, we control for various socio-economic
5 characteristics of the respondents. These factors can potentially confound our results and we
6 include them all in our multivariable analyses. Some of these factors are also important and can
7 capture community embeddedness and social support aspects of a person's life that can influence
8 psychosocial wellbeing, such as marital status and being born in the same community. We
9 further collect information on age of the respondent as well as his education and current
10 occupation. We have also profiled the wealth status of the respondents' households. We have
11 used a wealth index or *Equity Tool*, which is generally comparable across different contexts.[31]
12 This tool has been validated for Bangladesh and consists of seven questions according to its
13 latest update as of 2014. We have chosen the urban wealth scores and urban wealth quintile for
14 our study.

15 **Statistical Analyses**

16 To assess the relationship between mental wellbeing and social ties, we run different
17 regression models with different social network measures. We include the socioeconomic
18 characteristics in all the regression models and separately analyze the coefficients on these
19 additional controls. For the multivariate analyses, we use robust regression models to correct the
20 possible violation of the standard Gauss-Markov assumptions.[32] We standardized both the
21 mental health outcomes and also the continuous variables on the right-hand side in the regression
22 models and estimate the beta-coefficients. We further use ordered probit analyses for some
23 additional robustness checks (see Appendix). The outcome variable, GHQ-12 scores are discrete

1 in nature, hence, are prone to violate the basic normality conditions. Ordered probit models relax
 2 these assumptions. All econometric analyses are done using StataTM/MP 15.0.

3 **Table 1: Summary Statistics**

	Mean (SD)
Age, years	23.6 (3.6)
Currently Married, percent	52.2 (50.0)
Born in <i>Vashantek</i> , percent	44.2 (49.7)
Education, percent	
No formal education	83 (10.1)
Primary incomplete	290 (35.2)
Primary complete	106 (12.9)
Secondary incomplete	206 (25.0)
Secondary complete/Above	139 (16.9)
Equity Score	-0.016 (0.230)
Wealth Quintile, percent	
First	61 (7.4)
Second	325 (39.4)
Third	418 (50.7)
Fourth	16 (1.9)
Fifth	4 (0.5)
Occupations, percent	
Driver	138 (16.8)
Service Sector	125 (15.2)
Student	109 (13.2)
Business/Shop owner	100 (12.1)
Construction worker/Carpenter/Wall painter	88 (10.9)
Daily labor	58 (7.0)
Rickshaw puller/Van puller	43 (5.2)

4 Notes: Based on surveys of 824 respondents. Equity score is based on ownership of
 5 selected assets (namely, refrigerator, TV, almirah/wardrobe and electric fan) and
 6 household building materials. The wealth quintiles are based on equity scores with
 7 Bangladesh urban specific cutoffs. For occupations, other category is not included in
 8 the table.

1 FINDINGS

2 Socioeconomic Characteristics

3 We present the basic socioeconomic and demographic characteristics of the respondents in
4 Table 1. The average age of the respondents is 23.6 with a SD of 3.6. About 44 percent of the
5 respondents reported living in the study community since the time of their births. Interestingly,
6 52 percent of the respondents were married at the time of the survey. The respondent group also
7 exhibits generally low education level as 45 percent reports having either no or less than primary
8 level of education. The average schooling is about the same as nationally representative
9 household surveys.[33]

10 According to the generalizable equity score, with a mean of -0.016 and SD of 0.230, the
11 majority of our respondents come from second and third wealth quintiles, with very few (only
12 2.5 percent) from the upper two wealth quintiles. We find a considerable variation in occupations
13 the respondents are engaged in, namely driving, service in construction sectors and running small
14 businesses. About 13 percent of the respondents also reported being students at tertiary level
15 educational institutions.

16 Mental Health Status

17 We present both distribution and some summary statistics for mental health status of the
18 respondents in Figure 1. We find a considerable variation in GHQ-12 outcomes that ranged from
19 0 to 25. The average GHQ-12 score is about 9.2 with a SD of 4.9. We have further tested for
20 normality using Shapiro-Wilk test and the results basically reject the null hypothesis of
21 normality. This is natural given the discrete nature of GHQ-12 scoring and we further test the
22 robustness of our results using an ordered probit model that take into account the discrete nature
23 of our scoring (see Appendix).

[FIGURE 1 ABOUT HERE]

2 Social Network Analyses

3 A visual inspection of the social network suggests that the respondents can belong to one of
 4 the three broad types of components (see Figure 2): the largest component (N = 452 or 55
 5 percent), one of the 37 smaller self-contained components of sizes between 2 to 7 friends (N =
 6 105 or 13 percent) and 267 respondents (32 percent) who have not mentioned anybody in the
 7 community as a friend or nobody else in the community has mentioned them as a friend (see
 8 Table 2). They are completely isolated individuals within our target population with zero
 9 friendship ties within the community. On average, our sample has 1.6 ties per respondent,
 10 including the ones that report no friendship tie within the community.

11 **Table 2: Social Network Characteristics of the Respondents**

	Mean	SD
Respondents in each component, percent		
Large connected group	54.6	
Smaller groups	12.7	
Isolated with no referrals in any direction	32.4	
Number of friends, percent		
0	32.4	
1	26.3	
2	17.1	
3	11.0	
4	6.4	
5	3.9	
6 or more	2.8	
Average number of friendship ties	1.6	1.6
Average Centrality Scores		
All-closeness centrality	0.034	0.031
Betweenness centrality	0.00000662	0.000024
Eigenvector centrality	0.004	0.034

12 Notes: Based on 824 respondents. Each respondent reports the friendship ties within the
 13 community. The large connected group includes the biggest component where all subjects are
 14 connected with intermediate ties. Centrality measures are estimated using Pajek.

1 The average all-closeness centrality score is 0.034 for this network of 824 men (with a SD of
2 0.031, see Table 2). The average betweenness centrality score for this network of 824 men is 6.6
3 $\times 10^{-6}$ (with a SD of 24.0×10^{-6}) with an overall betweenness centralization of 0.0003. We
4 further estimate the average eigenvector centrality for the respondents, which is equal to 0.004
5 (with a SD of 0.034). The overall eigenvector centralization of the network is 0.0071. An
6 average eigenvector (Bonacich power) centrality of 0.004 suggests that on average, men in this
7 network do not hold very prestigious position with fairly low variation.

8 [FIGURE 2 ABOUT HERE]

9 **Association between mental wellbeing and social networks**

10 The results from our multivariate analyses to assess the association between mental health
11 outcome (standardized GHQ scores) and individuals' social network parameters are presented in
12 Table 3. All the continuous variables are standardized. In column (1) of Table 3, we find that
13 compared to an isolated respondent with no community friendship tie, a respondent belonging to
14 a small component has 0.098 SD lower GHQ score (95% Confidence Interval [CI] -0.327 to
15 0.131) and a respondent belonging to the larger component has 0.117 SD lower GHQ score (95%
16 CI -0.274 to 0.041).

17 In the next model in Column (2) of Table 3, we find mental health outcomes are
18 systematically better with higher degrees of ties or number of friends. Having an additional
19 friend is associated with 0.063 SD lower GHQ score (95% CI -0.106 to -0.021). In the next three
20 columns, we include different measures of centralities retaining all the controls. We find that a
21 one SD higher all-closeness centrality of a respondent is associated with 0.053 SD lower GHQ
22 score (95% CI -0.124 to 0.018, see Columns [3] in Table 3). We find similar results and more
23 precise estimates for betweenness and eigenvalue centralities. Respondents with one SD higher

1 betweenness centrality report about 0.103 SD lower GHQ score (95% CI -0.155 to -0.051) and
 2 one SD higher eigenvalue centrality report about 0.068 SD lower SHQ score (95% CI -0.103 to -
 3 0.033) controlling for other factors.

4 **Table 3: Multivariate Association between Mental Health Outcomes and Social Network**

	(1)	(2)	(3)	(4)	(5)
Component type					
Disconnected	Base				
Small	-0.098 (-0.327 - 0.131)				
Large	-0.117 (-0.274 - 0.041)				
Number of friend(s)		-0.063*** (-0.106 - -0.021)			
All closeness centrality (standardized)			-0.053 (-0.124 - 0.018)		
Betweenness centrality (standardized)				-0.103*** (-0.155 - -0.051)	
Eigenvalue centrality (standardized)					-0.068*** (-0.103 - -0.033)
Age (years)	0.012 (-0.013 - 0.037)	0.011 (-0.014 - 0.035)	0.012 (-0.013 - 0.037)	0.011 (-0.014 - 0.035)	0.014 (-0.011 - 0.038)
Education					
No formal education	Base	Base	Base	Base	Base
Primary incomplete	-0.333** (-0.622 - -0.043)	-0.315** (-0.602 - -0.027)	-0.326** (-0.616 - -0.037)	-0.320** (-0.609 - -0.030)	-0.339** (-0.631 - -0.048)
Primary complete	-0.450*** (-0.777 - -0.124)	-0.437*** (-0.763 - -0.112)	-0.443*** (-0.771 - -0.115)	-0.447*** (-0.774 - -0.120)	-0.444*** (-0.773 - -0.115)
Secondary incomplete	-0.269* (-0.574 - 0.035)	-0.267* (-0.570 - 0.035)	-0.267* (-0.572 - 0.037)	-0.272* (-0.576 - 0.033)	-0.277* (-0.583 - 0.029)
Secondary complete or above	-0.114 (-0.452 - 0.223)	-0.105 (-0.441 - 0.230)	-0.114 (-0.452 - 0.223)	-0.125 (-0.462 - 0.211)	-0.131 (-0.470 - 0.208)
= 1 if born outside Vashantek	0.169** (0.025 - 0.312)	0.184** (0.041 - 0.328)	0.167** (0.024 - 0.311)	0.182** (0.040 - 0.325)	0.163** (0.022 - 0.305)
= 1 if currently married	-0.190** (-0.367 - -0.013)	-0.198** (-0.375 - -0.022)	-0.188** (-0.364 - -0.011)	-0.179** (-0.353 - -0.004)	-0.171* (-0.346 - 0.004)
Equity Score (standardized)	-0.030 (-0.108 - 0.048)	-0.028 (-0.106 - 0.049)	-0.030 (-0.108 - 0.048)	-0.029 (-0.107 - 0.048)	-0.031 (-0.108 - 0.047)
Occupation Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	824	824	824	824	824
R-squared	0.036	0.047	0.036	0.043	0.038

5 Notes: The outcome variable is the standardized GHQ score in all five specifications. The robust 95% CIs are reported in
 6 parentheses. We also control for occupations, which are not reported here. *** p<0.01, ** p<0.05, * p<0.1.

7 In all five specifications, we include the socio-economic characteristics of the respondents as
 8 controls or possible confounding factors. The association between mental health outcomes and
 9 other covariates are quite suggestive. We find mental health to get worse with age, about 0.012
 10 SD higher with each additional year, however, while the point estimates are quite robust across

1 different models, they are not very precise. More educated respondents generally report lower
2 GHQ score, so more educated respondents typically have better mental health outcomes.
3 Interestingly, respondents born outside the community have better mental health outcomes.
4 Respondents who are currently married have 0.17-0.20 SD lower GHQ scores and coefficient
5 values are typically significant. We also find higher wealth as measured by equity score is
6 associated with lower GHQ score or better mental health outcomes.

7 **DISCUSSION**

8 Our findings signify the importance of social relationship in determining mental wellbeing in
9 resource-constrained contexts. Social ties are important components of a much broader idea of
10 social capital and observed outcomes can be associated with both the cognitive aspect of social
11 bonding and constructivist dimension of local social institutions.[34] Hence, our results further
12 illuminate the importance of social determinants of health in the context of mental health, a topic
13 that has garnered importance in both academic and policy literature in recent time.[12,17,35]

14 Our results show young men with better social ties and higher community embeddedness and
15 network report better mental health. We have used a number of different measures of social
16 network parameters at individual level that are typical of a person's connectedness within his
17 immediate community. While this captures a particular aspect of a person's position within a
18 broad spectrum of social capital he can accumulate over time, our estimates are mostly robust
19 and suggest that the connection with the peer of one's community is a strong predictor of his
20 mental health outcomes.

21 Additionally we should also highlight the overall high average GHQ-12 score for our sample.
22 While clinical diagnoses of disorder require closer scrutiny and assessment by mental health

1 professionals, such high score suggests potentially high psychosocial morbidity associated with
2 high level of stress, anxiety and possibly depression. Though we have focused on only one
3 neighborhood in Dhaka, the study area is not peculiar or remarkable in any observational way
4 suggesting wider implication and generalizability. In general, urban areas and youth population
5 are particularly prone to isolation and can suffer from psychological distresses and
6 psychosis.[36]

7 Social capital can influence the psychological wellbeing in a number of different ways and
8 our study can only speculate the possible channels through which social ties can affect mental
9 health for our study population.[21] A social network can help individuals to access material
10 resources such as loans, grants or health services.[11] We have found the respondents in our
11 sample primarily rely on family members for financial needs and community practitioners and
12 informal care providers such as salespersons in local pharmacies for health services. This
13 suggests, in our context, social network is contributing towards better mental health primarily
14 through socio-emotional supports and recreational needs. However, identifying the exact nature
15 of different channels will require further study and specific tools to measure different pathways
16 through which social ties can alter mental health outcomes.

17 Given the cross-sectional nature of our study, we cannot claim causality in our findings.
18 More specifically, it is possible that the association is primarily picking up selection bias where
19 people with certain psychosocial traits are self-selected into the social structure typified by
20 higher social ties and centrality.[3,18] We are also limited by using GHQ-12 to measure mental
21 health outcomes, which is not a clinical tool. We are also capturing, while important, very
22 specific types of social ties, namely friends within the community and a specific age group.

1 Obviously, our respondents can have social ties and network outside the community and also
2 through online social media.

3 Despite these limitations, the findings presented here further enhance our understanding of
4 social network determinants of mental health for a very interesting population. The post-
5 adolescent young population is particularly important because, Bangladesh, like many low-
6 middle income countries of the world, remains and will remain largely young for another
7 generation or so. High youth unemployment and underemployment can put strain on men due to
8 traditional gender expectations.[37] In this context, isolation and social disconnectedness can
9 contribute to lower mental health luring male youth to violence, which has become a concern
10 locally in the recent time. Thus, our findings have important implications for understanding
11 mental health outcomes and policies addressing psychosocial health issues for young men and
12 highlight the importance of social connection and ties in determining mental health among post-
13 adolescent population in the context of developing countries.

14 **Contributorship**

15 AR1 and MS conceived the study. AR led the analysis with guidance from NRB, AR2 and
16 MS. NRB led the social network data collection and analyses with guidance from AR1. AR2
17 managed the overall data collection and preliminary analyses with guidance from AR1 and MS.
18 AR1 wrote the first draft and the final manuscript with contribution from MS. All authors have
19 seen and approved the final version of the manuscript.

20 **Conflicts of interests** □

21 All authors declare no conflicts of interest.

22 **Role of funding source**

1 The study was funded by WOTRO Science for Global Development of Netherlands
2 Organization for Scientific Research (NWO) under grant number W 08,560.007. Funding source
3 did not play any role in designing of the study or collecting, analyzing or interpreting the data or
4 preparing this manuscript and deciding to submit the paper for publication.

5 **Data sharing**

6 All the data used in the preparation of this paper has been properly deidentified and no
7 personal identification information was retained in the final data sets. The data used in the paper
8 can be made available upon request and as per the policy of the journal.

9 **Ethical approval**

10 The Institutional Review Board at the BRAC School of Public Health, BRAC University
11 reviewed and approved both the proposal and the data collection protocols.

12 **BIBLIOGRAPHY**

- 1 WHO. Mental disorders. [Internet]. 2017 [cited 2017 September 29]. Available from:
2 <http://www.who.int/mediacentre/factsheets/fs396/en/>.
- 3 Murray, et al. Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases
4 and injuries and healthy life expectancy (HALE) for 188 countries, 1990–2013: quantifying the
5 epidemiological transition. *The Lancet*. 2015;386(10009):2145 - 2191.
- 6 Rosenquist JN, Fowler JH, Christakis NA. Social network determinants of depression. *Molecular*
7 *psychiatry*. 2011;16(3):273–281.
- 8 Steel Z, Marnane C, Iranpour C, Chey T, Jackson JW, Patel V, Silove D. The global prevalence of
9 common mental disorders: a systematic review and meta-analysis 1980–2013. *International*

- 1
2
3 journal of epidemiology. 2014;43:476-493.
4
5
- 6 5 Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, Charlson FJ, Norman RE,
7
8 Flaxman AD, Johns N, et al. Global burden of disease attributable to mental and substance use
9
10 disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*.
11
12 2013;382(9904):1575-1586.
13
14
- 15 6 Ferlander S. The importance of different forms of social capital for health. *Acta Sociologica*.
16
17 2007;50(2):115-128.
18
19
- 20 7 Andrade LH, Wang YP, Andreoni S, Silveira CM, Alexandrino-Silva C, Siu ER, Nishimura R,
21
22 Anthony JC, Gattaz WF, Kessler RC, et al. Mental disorders in megacities: findings from the Sao
23
24 Paulo megacity mental health survey, Brazil. *PloS one*. 2012;7(2):e31879.
25
26
- 27 8 Gronholm PC, Thornicroft G, Laurens KR, Evans-Lacko S. Mental health-related stigma and
28
29 pathways to care for people at risk of psychotic disorders or experiencing first-episode psychosis:
30
31 a systematic review. *Psychological Medicine*. 2017;47:1867–1879.
32
33
- 34 9 Baum FE, Ziersch AM. Social capital. *Journal of Epidemiology & Community Health*.
35
36 2003;57(5):320-323.
37
38
- 39 10 Webber M, Huxley P, Harris T. Social capital and the course of depression: six-month prospective
40
41 cohort study. *Journal of affective disorders*. 2011;129(1):149-157.
42
43
- 44 11 Fafchamps M, Lund S. Risk-sharing networks in rural Philippines. *Journal of Development*
45
46 *Economics*. 2003;71(2):261-287.
47
48
- 49 12 WHO. Review of Social Determinants and the Health Divide in the WHO European Region: Final
50
51 Report. Copenhagen: World Health Organization; 2008.
52
53
- 54 13 Graney MJ. Happiness and Social Participation in Aging. *Journal of Gerontology*. 1975 701-706.
55
56
57
58
59
60

- 1
2
3 14 Diener E, Seligman M. Very Happy People. *Psychological Science*. 2002.
4
5
6 15 Holder MD, Coleman B. The Contribution of Social Relationships to Children's Happiness. *Journal of*
7
8 *Happiness Studies*. 2009 329-349.
9
10
11 16 Cobb S. Social support as a moderator of life stress. *Psychosomatic medicine*. 1976;38(5):300-314.
12
13
14 17 De Silva MJ, McKenzie K, Harpham T, Huttly SRA. Social capital and mental illness: a systematic
15
16 *review*. *Journal of epidemiology and community health*. 2005;59(8):619-627.
17
18
19 18 Fowler JH, Christakis NA. Dynamic spread of happiness in a large social network: longitudinal
20
21 *analysis over 20 years in the Framingham Heart Study*. *BMJ*. 2008;337:a2338.
22
23
24 19 Bassett E, Moore S. Social capital and depressive symptoms: the association of psychosocial and
25
26 *network dimensions of social capital with depressive symptoms in Montreal, Canada*. *Social*
27
28 *Science & Medicine*. 2013;86:96-102.
29
30
31 20 Jackson MO. *Social and economic networks*. Princeton university press; 2010.
32
33
34 21 Berkman LF, Glass T, Brissette I, Seeman TE. From social integration to health: Durkheim in the new
35
36 *millennium*. *Social science & medicine*. 2000;51(6):843-857.
37
38
39 22 Fujiwara T, Kawachi I. A prospective study of individual-level social capital and major depression in
40
41 *the United States*. *Journal of Epidemiology and Community Health*. 2008;62(7):627-633.
42
43
44 23 Gayen K, Raeside R. Social networks, normative influence and health delivery in rural Bangladesh.
45
46 *Social science & medicine*. 2007;65(5):900-914.
47
48
49 24 Horng L, Dutta NC, Ahmed S, Rabbani A, Luby S, Uddin MJ. Peer Networking to Improve
50
51 *Knowledge of Child Health and Immunization Services Among Recently Relocated Mothers in*
52
53 *Slums of Dhaka, Bangladesh*. *Open Forum Infectious Diseases*. 2016;3(S1):625.
54
55
56
57
58
59
60

- 1
2
3 25 Perkins JM, Subramanian SV, Christakis NA. Social networks and health: a systematic review of
4 sociocentric network studies in low-and middle-income countries. *Social Science & Medicine*.
5 2015;125:60-78.
6
7
8
9
10 26 Islam MN, Iqbal KF. Mental Health and Social Support. *The Chittagong Univ. J. B. Sci.*
11 2008;3(1&2):95-107.
12
13
14
15 27 Hossain MM, Siddique NEA, Habib MFB. Status of Marital Adjustment, Life Satisfaction and Mental
16 Health of Tribal (Santal) and Non-Tribal Peoples in Bangladesh: A Comparative Study. *IOSR*
17 *Journal Of Humanities And Social Science (IOSR-JHSS)*. 2017;22(4):5-12.
18
19
20
21
22 28 Hankins M. The reliability of the twelve-item general health questionnaire (GHQ-12) under realistic
23 assumptions. *BMC public health*. 2008;8(1):355.
24
25
26
27 29 Marsden PV. Recent developments in network measurement. In: Carrington PJ, Scott J, Wasserman S.
28 *Models and methods in social network analysis*. Cambridge University Press; 2005. p. 8-30.
29
30
31
32 30 Bonacich P. Power and Centrality: A Family of Measures. *American Journal of Sociology*. 1987 1170-
33 1182.
34
35
36
37 31 Chakraborty NM, Fry K, Behl R, Longfield K. Simplified asset indices to measure wealth and equity
38 in health programs: a reliability and validity analysis using survey data from 16 countries. *Global*
39 *Health: Science and Practice*. 2016;4(1):141-154.
40
41
42
43
44 32 Wooldridge JM. *Econometric analysis of cross section and panel data*. Cambridge (MA): The MIT
45 Press; 2002.
46
47
48
49 33 BBS. *Household Income and Expenditure Survey, 2010*. Dhaka, Bangladesh: Bangladesh Bureau of
50 Statistics; 2011.
51
52
53
54 34 Vigo D, Thornicroft G, Atun R. Estimating the true global burden of mental illness. *The Lancet*
55
56
57
58
59
60

1
2
3 Psychiatry. 2016;3(2):171-178.
4

5
6 35 Krabbendam L, Os JV. Schizophrenia and urbanicity: a major environmental influence—conditional
7
8 on genetic risk. Schizophrenia bulletin. 2005;31(4):795-799.
9

10
11 36 Economist Intelligence Unit. High university enrolment, low graduate employment Analysing the
12
13 paradox in Afghanistan, Bangladesh, India, Nepal, Pakistan and Sri Lanka. [Internet]. 2014 [cited
14
15 2015 Jun 12]. Available from: <http://goo.gl/sVKaD9>.
16

17
18 37 Lund C, Breen A, Flisher AJ, Kakuma R, Corrigall J, Joska JA, Swartz L, Patel V. Poverty and
19
20 common mental disorders in low and middle income countries: a systematic review. Social science
21
22 & medicine. 2010;71(3):517-528.
23
24

25 1
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 1: Distribution of GHQ-12 score

Notes. Based on 824 respondents. Here we report the non-standardized GHQ scores. The mean is shown as the vertical red line and the median is shown as the vertical blue line. GHQ is the aggregate of 12 questions with possible values of 0, 1, 2 and 3. The scores of all 12 questions are added to measure the composite score for a respondent.

For peer review only

1
2
3 **1 Figure 2: Visualization of the friendship network of the 824 young men of Vashantek**
4
5
6

7
8 **2** Notes: Here we show the socio network graph for 824 respondents. Each node represents an individual respondent.
9 **3** The connector shows the friendship ties between two respondents. There are 267 respondents who are completely
10 **4** isolated (represented by v100 in the figure). The largest component consists of 450 respondents who are all
11 **5** connected with each other through intermediate ties. We also have 37 smaller components with smaller networks.
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 1 **A social network analysis of psychological morbidity in an urban slum of Bangladesh: a**
4
5 2 **cross-sectional study based on a community census**
6
7
8
9

10 3 **APPENDIX: ROBUSTNESS CHECKS**
11

12 4 To test the validity of our statistical findings, we carry out some additional robustness checks
13
14 5 to see whether our estimates are sensitive to the models we have determined. The results are
15
16 6 presented in Appendix Table 1. We first restrict our models by dropping the 267 isolated
17
18 7 respondents. It is possible that our centrality measures can pick up the outcome differences
19
20 8 between these two groups. However, results in row (1) of Appendix Table 1 suggest this is not
21
22 9 the case. The estimate on the sub-sample is -0.098 (95% CI -0.151 to -0.044), which is very
23
24 10 similar to the value we found in column (4) in Table 3. The estimated coefficient on betweenness
25
26 11 centrality is not sensitive to excluding the isolated nodes. We also find that betweenness
27
28 12 centrality has too many zeros, hence, we define a dummy for respondents with non zero values
29
30 13 and re-estimate the model. We find negative association between mental health outcomes of the
31
32 14 respondents and those with non-zero betweenness centrality (-0.163, 95% CI -0.321 to -0.004,
33
34 15 see row [2]). The results are very similar for eigenvector centrality as well (see rows [3] and [4]
35
36 16 in Appendix Table 1). We also use a new measure of being influential within a network namely
37
38 17 input proximity prestige index. We find that one SD higher value in this index is associated with
39
40 18 0.06 SD lower GHQ score (95% CI -0.124 to 0.010, see row [5]), suggesting better mental health
41
42 19 outcomes.
43
44
45
46
47
48
49

50 20 As we noted earlier, GHQ scores are essentially discrete in nature and we could actually
51
52 21 reject null hypothesis of normality distribution in GHQ scores. So we have re-estimated the
53
54 22 models with three centrality scores using ordered probit models and relaxed the normality
55
56
57
58
59
60

1 assumption in the outcome variables. The results are presented in rows (6-8). We find that both
 2 the point estimates and also the second moments are generally not sensitive to the alternative
 3 regression models.

4 **Appendix Table 1: Robustness Checks**

		Coefficient	(95% CI)	N	R ²
(1)	Betweenness Centrality (standardized) excluding isolated respondents	-0.098***	(-0.151 to -0.044)	557	0.058
(2)	= 1 if Betweenness Centrality > 0	-0.163**	(-0.321 to -0.004)	824	0.038
(3)	Eigenvector Centrality (standardized) excluding isolated respondents	-0.060***	(-0.098 to -0.023)	557	0.051
(4)	= 1 if Eigenvector Centrality > 0	-0.117	(-0.257 to 0.023)	824	0.037
(5)	Input Proximity Prestige (standardized)	-0.057*	(-0.124 to 0.010)	824	0.036
Results from ordered probit models					
(6)	All closeness centrality (standardized)	-0.052	(-0.124 to 0.019)	824	
(7)	Betweenness centrality (standardized)	-0.106***	(-0.177 to -0.034)	824	
(8)	Eigenvalue centrality (standardized)	-0.064*	(-0.133 to 0.006)	824	

5 Note: The outcome variable is the standardized GHQ score in all specifications. In specifications (1) and (3), we
 6 drop the respondents who do not have any friendship tie. In specifications (2) and (4), we use an indicator variable
 7 for respondents with non-zero centrality values. In specifications (6-8), we use ordered probit models for the discrete
 8 standardized GHQ score as the outcome variables. In all specifications, we have retained the control variables that
 9 we include in Table 3. The robust p-values are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

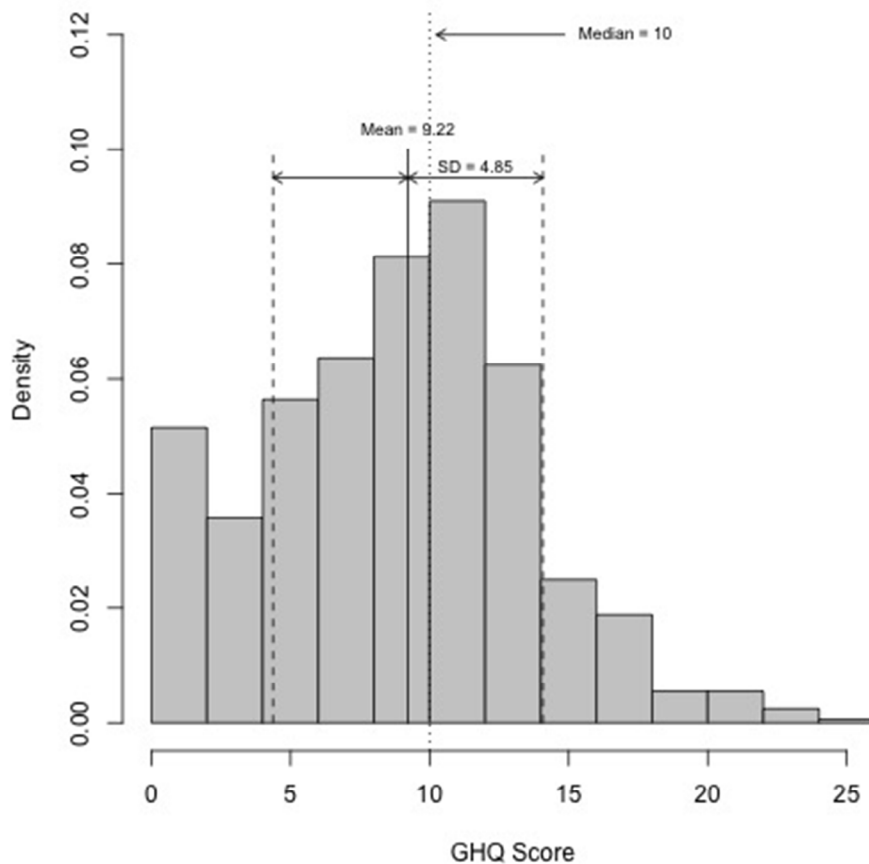


Figure 1: Distribution of GHQ-12 score

169x169mm (72 x 72 DPI)



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

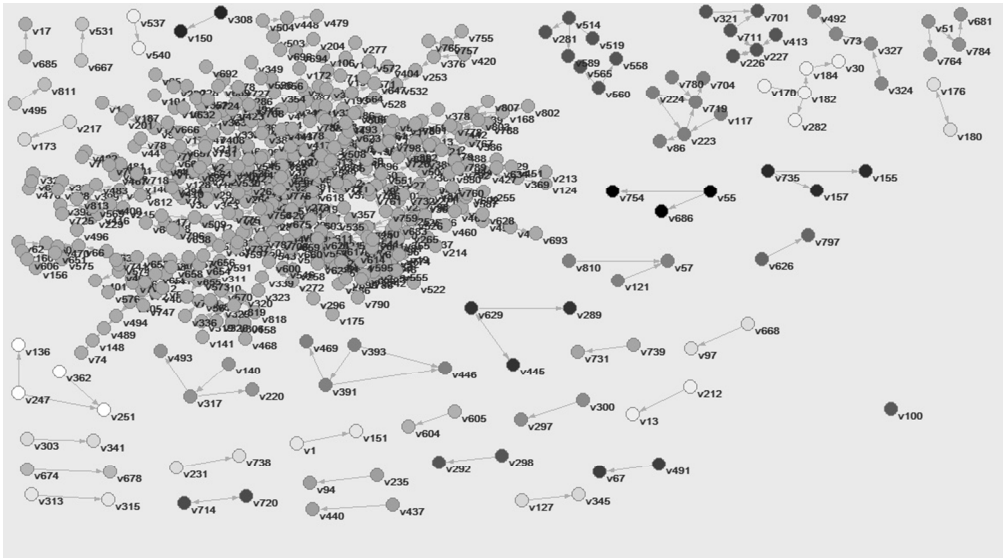


Figure 2: Visualization of the friendship network of the 824 young men of Vashantek

404x224mm (72 x 72 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	N/A
		(c) Explain how missing data were addressed	N/A
		(d) If applicable, describe analytical methods taking account of sampling strategy	8
		(e) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-11
		(b) Indicate number of participants with missing data for each variable of interest	N/A

Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-13
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	See Appendix
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

A social network analysis of psychological morbidity in an urban slum of Bangladesh: a cross-sectional study based on a community census

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-020180.R1
Article Type:	Research
Date Submitted by the Author:	27-Feb-2018
Complete List of Authors:	Rabbani, Atonu; Dhaka University, Department of Economics; BRAC University James P Grant School of Public Health, Biju, Nabila; BRAC University James P Grant School of Public Health, Rizwan, Ashfique; BRAC University James P Grant School of Public Health, Sarker, M; BRAC University James P Grant School of Public Health, ; Institute of Public Health
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Global health, Sociology, Public health
Keywords:	MENTAL HEALTH, PUBLIC HEALTH, Social Network, Social Determinants

SCHOLARONE™
Manuscripts

1
2
3 1 **A social network analysis of psychological morbidity in an urban slum of Bangladesh: a**
4
5 2 **cross-sectional study based on a community census**
6
7

8 3 Atonu Rabbani^{a,*}, Nabila Rahman Biju^b, Ashfique Rizwan^c, Malabika Sarker^d
9
10

11 4
12 5 ^aDepartment of Economics, University of Dhaka, Dhaka 1000, Bangladesh & BRAC School of
13 6 Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin Ahmed Sharani,
14 7 Mohakhali, Dhaka-1212, Bangladesh. Email: atonu.rabbani@gmail.com,
15 8 atonu.rabbani@econdu.ac.bd
16 8

17 9 ^bBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
18 10 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh. Email: nabila.rahman@bracu.ac.bd

19 11 ^cBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
20 12 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh. Email: ashfique.rizwan@bracu.ac.bd

21 13 ^dBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
22 14 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh & Institute of Public Health, Im
23 15 Neuenheimer Feld 130.3, Marsilius Arkaden - 6. Stock, 69120 Heidelberg, Germany. Email:
24 16 malabika@bracu.ac.bd
25 16
26 17
27 17
28 18
29 18
30 18
31 18
32 18
33 18

34 19 ***Corresponding Author:**
35
36

37 20 Atonu Rabbani
38 21 Associate Professor
39 22 Department of Economics
40 23 University of Dhaka
41 24 Dhaka 1000, Bangladesh
42 25 Email: atonu.rabbani@gmail.com
43 26 Phone: +8801730441787
44 26
45 27
46
47

48 28 **Word Count:**
49

50 29 Paper – 3,949 (3,437 without tables and figure placement texts)
51
52

53 30 Abstract – 219
54
55
56
57
58
59
60

Abstract

Objectives To test whether social ties play any roles in mitigating depression and anxiety, as well as fostering mental health among young men living in a poor urban community.

Setting A cohort of all young men living in an urban slum in Dhaka, the capital of Bangladesh.

Participants All 18 to 29 years old men (N = 824) living in the low income urban community at the time of the survey.

Primary and secondary outcome measures Unspecified psychological morbidity measured by Generalized Health Questionnaire (GHQ 12), where lower scores suggest better mental status.

Results The GHQ scores (mean = 9.2, SD = 4.9) suggest significant psychological morbidity among the respondents. However, each additional friend is associated with 0.063 SD lower GHQ score (95% CI -0.106 to -0.021). Between centrality measuring relative importance of the respondent within his social network is also associated with 0.103 SD lower GHQ score (95% CI -0.155 to -0.051), as are other measures of social network ties. Among other factors, married respondents and recent migrants also report better mental health status.

Conclusions Our results underscore the importance of social connection in providing buffer against stress and anxiety through psychosocial support from one's peer in a resource constraint urban setting. Our findings also suggest incorporating social network and ties in designing mental health policies and interventions.

Keywords: Mental health outcomes; social network; urban young men; regression analyses.

1 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 2 • Our analyses take advantage of a census of young men in a resource constraint low-income
3 urban community in Bangladesh to establish the roles social network and community ties
4 may play in determining better mental health outcomes.
- 5 • The measurement of social network is based on roster-based approach where friendship
6 connections for all possible pairs of respondents are carefully assessed and validated.
- 7 • We take advantage of a locally adopted GHQ-12 to assess unspecified mental health
8 outcomes along with detailed socioeconomic characteristics of our respondents.
- 9 • Cross sectional data limits causal interpretations and cannot rule out reverse causality of
10 otherwise robust relationships and community ties through friendship relations can capture
11 only limited aspects of respondents' social network.

1 INTRODUCTION

2 Mental illness and disorders generally refer to “abnormal thoughts, perceptions, emotions,
3 behaviour and relationships with others.” [1] Mental illness contributes about 7.1 percent to
4 global disease burden and the cost of mental disorders such as depression can be enormous. [2,3]
5 Over lifetime, mental disorder can adversely affect one-third of the global population. [4] As of
6 2010, close to nine hundred million people were estimated to suffer from certain mental health
7 issues including depression, anxiety and substance abuse. [5] The burden of mental health is also
8 likely to increase with growing urbanization in the developing countries. [6,7] The poor
9 neighborhoods and low-income communities can potentially offer more stressful environments
10 for the urban citizens. [8] Hence, one can potentially infer a larger share of the global mental
11 health burden will be borne by the lower income population living in challenging environments
12 in the newly urbanized developing countries. This will further be compounded by social stigma
13 and general misinformation associated with mental health symptoms and resulting low
14 psychosocial care seeking in the developing countries. [9]

15 Social capital can be multifaceted and the definitions vary in the literature as they aim to
16 capture the different aspects of social engagements for an individual. [10] Social capital
17 encompasses civic engagement, trust, reciprocity and certain norms. Moreover, it can both be a
18 structural feature of the community or a group and owned by individual to rely and exploit to
19 command over resources to ensure his or her wellbeing. [11,12] Horizontal nature of the ties, for
20 example, friendship network and community embeddedness are considered a defining feature of
21 one’s social capital and prior literature typically associate resulting social capital with socially
22 desirable health outcomes. [13]

1
2
3 1 There is a growing consensus that the quality of social ties and deeper social embeddedness
4
5 2 are important determinants of mental health. [14,15,16] Lack of social ties has been found to be a
6
7 3 risk factor for a number of mental health indicators. [17,18,19,20] Through providing attachment
8
9 4 and buffer, social network and ties can have both extrinsic and intrinsic values for an individual's
10
11 5 mental or psychological wellbeing. [21] Prior studies have shown the positive roles social
12
13 6 connection can play in lowering depressive episodes. [20,22] Depressive symptoms are also less
14
15 7 likely to manifest themselves for people who are more central within the group they belong to.
16
17 8 [23] Mental state of mind, like happiness, can also proliferate for people with social networks
18
19 9 that are closer in terms of geographic distance. [19]

20
21
22
23
24 10 In the context of Bangladesh, social network has been found to contribute towards health
25
26 11 service delivery in both rural and urban areas. [24,25] However, we have limited information on
27
28 12 how social ties and network properties can determine mental health outcomes in urban
29
30 13 Bangladesh and similar other low-income contexts. Social network has been found to have
31
32 14 strong association with positive mental health outcomes. However, these studies have taken
33
34 15 place mostly in the developed countries by taking advantage of large, often longitudinal, cohort
35
36 16 studies and population level data. [19,20,22,23] We intend to contribute to the growing literature
37
38 17 on social network as a determinant of mental health by exploiting a community level census of
39
40 18 young men in a slum of Dhaka.

41 42 43 44 45 46 47 19 **METHOD**

48 49 50 20 **Study Design**

51
52 21 We follow a cross-sectional study design based on individual respondents from a census of
53
54 22 young men living in an urban slum at the time of the survey (N = 824). Census allows us to

1 enumerate friendship ties along with directions between any two respondents among possible
2 339,076 ties. We also collect mental health outcome measures along with detailed socio-
3 economic characteristics of the respondents.

4 **Study Setting**

5 We have carried out our study in a particular but otherwise typical urban community in
6 Dhaka, namely *Vashantek*. The entire *Vashantek* slum is geographically divided into four
7 subdivisions with a total population of around 31 thousand or about 5.5 thousand households.
8 We choose to work in a particular subdivision and carry out a census of all men between the age
9 of 18 and 29 years. The study is part of a larger project, which focuses on gender norms, risky
10 sexual behavior and mental health within this particular population. These topics have often
11 focused on adolescent or female population. Hence, we chose post-adolescent young men in low-
12 income urban community as study population to provide some novel and unique perspectives to
13 the relevant literature. We collect baseline information on a number of socioeconomic variables
14 and detailed social network information for all the targeted respondents. The site and the setting
15 meet the necessary criteria for usual social network analyses. [26]

16 **Sample and sampling technique**

17 We collect information for all men between the ages of 18 and 29 in our targeted site.
18 Initially we list all the households in the study community with men who fit the age criteria. We
19 ask each household if it has an 18-29 year old man living in the household. Then we follow up
20 with their full names, contact information and their availability for a more detailed survey. We
21 find a total of 942 potential respondents from 790 households through this initial listing process.
22 After thorough training of the data collectors and questionnaire pretesting, we send nine data
23 collectors to carry out the surveys. All enumerators were experienced data collectors and also

1 had experience in mobile based the quantitative survey through Survey CTO. The enumerators
2 carry out the interviews over 26 days during the month of December 2016.

3 We collect information on demographic, economic, sexual practice and friendship related
4 information using a structured questionnaire. Some of the respondents moved out of the slum
5 between the initial household listing and the follow up survey. We also find households with a
6 potential respondent living outside the community but previously listed as a household member.
7 We also exclude individuals who have communication impairments and not agreeing to provide
8 written consents. The final cohort consists of 824 young men of 18 to 29 years of age living in
9 our study area. We have carried out all analyses on this sample.

10 **Patient and Public Involvement statement**

11 No patients were involved in designing the study or developing the research questions, nor
12 they were involved in analyzing or interpreting the findings. The study is based on a community
13 based sample of individuals who meet the pre-specific criteria. We have plans to discuss some of
14 general implications of the study findings through workshops as well as through a series of radio
15 shows aiming to address mental health problems affecting young men in Dhaka.

16 **Measures of Mental Wellbeing**

17 We use the 12-question version of the General Health Questionnaire (GHQ-12) to assess the
18 mental wellbeing of individuals where a higher score generally suggests a worse mental health
19 outcome. It is an often-used survey based tool to measure the population morbidity of non-
20 psychotic and minor psychiatric disorders. GHQ-12 has been implemented and validated widely
21 in different contexts in both developed and developing countries, including Bangladesh. [27,28]
22 Due to its precise and concise nature and validity in the context of Bangladesh, we consider this
23 tool to be appropriate for our study to assess any non-specific psychiatric morbidity among the

1 respondents. [29] We estimate *Cronbach's α* , and a value of 0.83 suggests high internal
2 consistency. We further carry out exploratory factor analysis and high individual variance for
3 each factor suggests high reliability of the score in our sample. The detailed item-wise responses
4 are reported in Appendix A.

5 **Social Network Analysis (SNA) Parameters**

6 For the social network analysis, we ask each respondent to name the close friend(s) within
7 the community and where they live (particular landmark/household identifier within the slum).
8 After confirming the proper identification of all the close friends mentioned by the respondents,
9 we construct a 824×824 square *sociomatrix* showing direct friendship ties with value 1 or 0. [30]
10 We then use network analysis software *Pajek* to analyze this dataset. We estimate different social
11 network parameters for each of our respondents measuring embeddedness, and centrality of each
12 respondent within the friendship network. These measures capture richer aspects of social
13 network of the respondents (for definitions of the different social network parameters, see
14 Appendix B). [31,32] For robustness check and sensitivity analyses, we use non-linear versions
15 of some of our centrality measures, due to the overrepresentation of zeros in our sample, which
16 indicates absence of any ties between individuals. [20] We also estimate some additional
17 measures of the nature of the social network at individual levels to carry out further sensitivity
18 analyses (see Appendix C).

19 **Socioeconomic Characteristics**

20 Given the observational nature of our study, we control for various socio-economic
21 characteristics of the respondents. These factors can potentially confound our results and we
22 include them all in our multivariable analyses. Some of these factors are also important and can
23 capture community embeddedness and social support aspects of a person's life that can influence

1 psychosocial wellbeing, such as marital status and being born in the same community. We
2 further collect information on age of the respondent as well as his education and current
3 occupation. We have also profiled the wealth status of the respondents' households. We have
4 used a wealth index or *Equity Tool*, which is generally comparable across different contexts. [33]
5 This tool has been validated for Bangladesh and consists of seven questions according to its
6 latest update as of 2014. We have chosen the urban wealth scores and urban wealth quintile for
7 our study.

8 **Statistical Analyses**

9 To assess the relationship between mental wellbeing and social ties, we run different
10 regression models with different social network measures. We include the socioeconomic
11 characteristics in all the regression models and separately analyze the coefficients on these
12 additional controls. For the multivariable analyses, we use robust regression models to correct
13 the possible violation of the standard Gauss-Markov assumptions (see Appendix D. [34] We
14 standardized both the mental health outcomes and also the continuous variables on the right-hand
15 side in the regression models and estimate the beta-coefficients. We further use ordered probit
16 analyses for some additional robustness checks (see Appendix C). The outcome variable, GHQ-
17 12 scores are discrete in nature, hence, are prone to violate the basic normality conditions.
18 Ordered probit models relax these assumptions (see Appendixes C and D). All econometric
19 analyses are done using StataTM/MP 15.0.

1

Table 1: Summary Statistics

	Mean (SD)
Age, years	23.6 (3.6)
Currently Married, percent	52.2 (50.0)
Born in <i>Vashantek</i> , percent	44.2 (49.7)
Education, percent	
No formal education	83 (10.1)
Primary incomplete	290 (35.2)
Primary complete	106 (12.9)
Secondary incomplete	206 (25.0)
Secondary complete/Above	139 (16.9)
Equity Score	-0.016 (0.230)
Wealth Quintile, percent	
First	61 (7.4)
Second	325 (39.4)
Third	418 (50.7)
Fourth	16 (1.9)
Fifth	4 (0.5)
Occupations, percent	
Driver	138 (16.8)
Service Sector	125 (15.2)
Student	109 (13.2)
Business/Shop owner	100 (12.1)
Construction worker/Carpenter/Wall painter	88 (10.9)
Daily labor	58 (7.0)
Rickshaw puller/Van puller	43 (5.2)

Notes: Based on surveys of 824 respondents. Equity score is based on ownership of selected assets (namely, refrigerator, TV, almirah/wardrobe and electric fan) and household building materials. The wealth quintiles are based on equity scores with Bangladesh urban specific cutoffs. For occupations, other category is not included in the table.

7 FINDINGS

8 Socioeconomic Characteristics

9 We present the basic socioeconomic and demographic characteristics of the respondents in
 10 Table 1. The average age of the respondents is 24 with a SD of 3.6 About 44 percent of the

1 respondents reported living in the study community since the time of their births. Interestingly,
2 52 percent of the respondents were married at the time of the survey. The respondent group also
3 exhibits generally low education level as 45 percent reports having either no or less than primary
4 level of education. The average schooling is about the same as nationally representative
5 household surveys. [35]

6 According to the generalizable equity score, with a mean of -0.016 and SD of 0.230, the
7 majority of our respondents come from second and third wealth quintiles, with very few (only
8 2.5 percent) from the upper two wealth quintiles. We find a considerable variation in occupations
9 the respondents are engaged in, namely driving, service in construction sectors and running small
10 businesses. About 13 percent of the respondents also reported being students at tertiary level
11 educational institutions.

12 **Mental Health Status**

13 We present both distribution and some summary statistics for mental health status of the
14 respondents in Figure 1. We find a considerable variation in GHQ-12 outcomes that ranged from
15 0 to 25. The average GHQ-12 score is about 9.2 with a SD of 4.9. We have further tested for
16 normality using Shapiro-Wilk test and the results basically reject the null hypothesis of
17 normality. This is natural given the discrete nature of GHQ-12 scoring and we further test the
18 robustness of our results using an ordered probit model that take into account the discrete nature
19 of our scoring (see Appendix C).

20 [FIGURE 1 ABOUT HERE]

1 Social Network Analyses

2 A visual inspection of the social network suggests that the respondents can belong to one of
 3 the three broad types of components (see Figure 2): the largest component (N = 452 or 55
 4 percent), one of the 37 smaller self-contained components of sizes between 2 to 7 friends (N =
 5 105 or 13 percent) and 267 respondents (32 percent) who have not mentioned anybody in the
 6 community as a friend or nobody else in the community has mentioned them as a friend (see
 7 Table 2). They are completely isolated individuals within our target population with zero
 8 friendship ties within the community. On average, our sample has 1.6 ties per respondent,
 9 including the ones that report no friendship tie within the community.

10 **Table 2: Social Network Characteristics of the Respondents**

	Mean	SD
Respondents in each component, percent		
Large connected group	54.6	
Smaller groups	12.7	
Isolated with no referrals in any direction	32.4	
Number of friends, percent		
0	32.4	
1	26.3	
2	17.1	
3	11.0	
4	6.4	
5	3.9	
6 or more	2.8	
Average number of friendship ties	1.6	1.6
Average Centrality Scores		
All-closeness centrality	0.034	0.031
Betweenness centrality	0.00000662	0.000024
Eigenvector centrality	0.004	0.034

11 Notes: Based on 824 respondents. Each respondent reports the friendship ties within the
 12 community. The large connected group includes the biggest component where all subjects are
 13 connected with intermediate ties. Centrality measures are estimated using Pajek.

14 The average all-closeness centrality score is 0.034 for this network of 824 men (with a SD of
 15 0.031, see Table 2). The average betweenness centrality score for this network of 824 men is 6.6

1 $\times 10^{-6}$ (with a SD of 24.0×10^{-6}) with an overall betweenness centralization of 0.0003. We
2 further estimate the average eigenvector centrality for the respondents, which is equal to 0.004
3 (with a SD of 0.034). The overall eigenvector centralization of the network is 0.0071. An
4 average eigenvector (Bonacich power) centrality of 0.004 suggests that on average, men in this
5 network do not hold very prestigious position with fairly low variation.

6 [FIGURE 2 ABOUT HERE]

7 **Association between mental wellbeing and social networks**

8 The results from our multivariable regression analyses to assess the association between
9 mental health outcome (standardized GHQ scores) and individuals' social network parameters
10 are presented in Table 3. All the continuous variables are standardized. In column (1) of Table 3,
11 we find that compared to an isolated respondent with no community friendship tie, a respondent
12 belonging to a small component has 0.098 SD lower GHQ score (95% Confidence Interval [CI] -
13 0.327 to 0.131) and a respondent belonging to the larger component has 0.117 SD lower GHQ
14 score (95% CI -0.274 to 0.041).

15 In the next model in Column (2) of Table 3, we find mental health outcomes are
16 systematically better with higher degrees of ties or number of friends. Having an additional
17 friend is associated with 0.063 SD lower GHQ score (95% CI -0.106 to -0.021). In the next three
18 columns, we include different measures of centralities retaining all the controls. We find that a
19 one SD higher all-closeness centrality of a respondent is associated with 0.053 SD lower GHQ
20 score (95% CI -0.124 to 0.018, see Columns [3] in Table 3). We find similar results and more
21 precise estimates for betweenness and eigenvalue centralities. Respondents with one SD higher
22 betweenness centrality report about 0.103 SD lower GHQ score (95% CI -0.155 to -0.051) and

1 one SD higher eigenvalue centrality report about 0.068 SD lower SHQ score (95% CI -0.103 to -
 2 0.033) controlling for other factors.

3 **Table 3: Multivariable Association between Mental Health Outcomes and Social Network**

	(1)	(2)	(3)	(4)	(5)
Component type					
Disconnected	Base				
Small	-0.098 (-0.327 to 0.131)				
Large	-0.117 (-0.274 to 0.041)				
Number of friend(s)		-0.063*** (-0.106 to -0.021)			
All closeness centrality (standardized)			-0.053 (-0.124 to 0.018)		
Betweenness centrality (standardized)				-0.103*** (-0.155 to -0.051)	
Eigenvalue centrality (standardized)					-0.068*** (-0.103 to -0.033)
Age (years)	0.012 (-0.013 to 0.037)	0.011 (-0.014 to 0.035)	0.012 (-0.013 to 0.037)	0.011 (-0.014 to 0.035)	0.014 (-0.011 to 0.038)
Education					
No formal education	Base	Base	Base	Base	Base
Primary incomplete	-0.333** (-0.622 to -0.043)	-0.315** (-0.602 to -0.027)	-0.326** (-0.616 to -0.037)	-0.320** (-0.609 to -0.030)	-0.339** (-0.631 to -0.048)
Primary complete	-0.450*** (-0.777 to -0.124)	-0.437*** (-0.763 to -0.112)	-0.443*** (-0.771 to -0.115)	-0.447*** (-0.774 to -0.120)	-0.444*** (-0.773 to -0.115)
Secondary incomplete	-0.269* (-0.574 to 0.035)	-0.267* (-0.570 to 0.035)	-0.267* (-0.572 to 0.037)	-0.272* (-0.576 to 0.033)	-0.277* (-0.583 to 0.029)
Secondary complete or above	-0.114 (-0.452 to 0.223)	-0.105 (-0.441 to 0.230)	-0.114 (-0.452 to 0.223)	-0.125 (-0.462 to 0.211)	-0.131 (-0.470 to 0.208)
= 1 if born at Vashantek	-0.169** (-0.312 to -0.025)	-0.184** (-0.328 to -0.041)	-0.167** (-0.311 to -0.024)	-0.182** (-0.325 to -0.040)	-0.163** (-0.305 to -0.022)
= 1 if currently married	-0.190** (-0.367 to -0.013)	-0.198** (-0.375 to -0.022)	-0.188** (-0.364 to -0.011)	-0.179** (-0.353 to -0.004)	-0.171* (-0.346 to 0.004)
Equity Score (standardized)	-0.030 (-0.108 to 0.048)	-0.028 (-0.106 to 0.049)	-0.030 (-0.108 to 0.048)	-0.029 (-0.107 to 0.048)	-0.031 (-0.108 to 0.047)
Occupation Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	824	824	824	824	824
R-squared	0.036	0.047	0.036	0.043	0.038

Notes: The outcome variable is the standardized GHQ score in all five specifications. A higher GHQ score suggests worse mental health outcomes. The robust 95% CIs are reported in parentheses. We also control for occupations, which are not reported here. *** p<0.01, ** p<0.05, *p<0.1.

7 In all five specifications, we include the socio-economic characteristics of the respondents as
 8 controls or possible confounding factors. The association between mental health outcomes and
 9 other covariates are quite suggestive. We find mental health to get worse with age, about 0.012
 10 SD higher with each additional year, however, while the point estimates are quite robust across

1 different models, they are not very precise. More educated respondents generally report lower
2 GHQ score, so more educated respondents typically have better mental health outcomes.
3 Interestingly, respondents born inside the community have better mental health outcomes.
4 Respondents who are currently married have 0.17-0.20 SD lower GHQ scores and coefficient
5 values are typically significant. We also find higher wealth as measured by equity score is
6 associated with lower GHQ score or better mental health outcomes.

7 **DISCUSSION**

8 Our findings signify the importance of social relationship in determining mental wellbeing in
9 resource-constrained contexts. Social ties are important components of a much broader idea of
10 social capital and observed outcomes can be associated with both the cognitive aspect of social
11 bonding and constructivist dimension of local social institutions. [20] Hence, our results further
12 illuminate the importance of social determinants of health in the context of mental health, a topic
13 that has garnered importance in both academic and policy literature in recent time. [13,18,36]

14 Our results show young men with better social ties and higher community embeddedness and
15 network report better mental health. We have used a number of different measures of social
16 network parameters at individual level that are typical of a person's connectedness within his
17 immediate community. While this captures a particular aspect of a person's position within a
18 broad spectrum of social capital he can accumulate over time, our estimates are mostly robust
19 and suggest that the connection with the peer of one's community is a strong predictor of his
20 mental health outcomes.

21 Additionally we should also highlight the overall high average GHQ-12 score for our sample
22 from a general population. For example, in the context of Bangladesh, previously researchers

1 have found GHQ-12 score of 20 with a SD of 3 among the diagnosed mental patients. [27] While
2 clinical diagnoses of disorder require closer scrutiny and assessment by mental health
3 professionals, such high score suggests potentially high psychosocial morbidity associated with
4 high level of stress, anxiety and possibly depression. Though we have focused on only one
5 neighborhood in Dhaka, the study area is not peculiar or remarkable in any observational way
6 suggesting wider implication and generalizability. In general, urban areas and youth population
7 are particularly prone to isolation and can suffer from psychological distresses and psychosis.
8 [36]

9 Social capital can influence the psychological wellbeing in a number of different ways and
10 our study can only speculate the possible channels through which social ties can affect mental
11 health for our study population. [21] A social network can help individuals to access material
12 resources such as loans, grants or health services. [12] We have found the respondents in our
13 sample primarily rely on family members for financial needs and community practitioners and
14 informal care providers such as salespersons in local pharmacies for health services. This
15 suggests, in our context, social network is contributing towards better mental health primarily
16 through socio-emotional supports and recreational needs. However, identifying the exact nature
17 of different channels will require further study and specific tools to measure different pathways
18 through which social ties can alter mental health outcomes.

19 Given the cross-sectional nature of our study, we cannot claim causality in our findings.
20 More specifically, it is possible that the association is primarily picking up selection bias where
21 people with certain psychosocial traits are self-selected into the social structure typified by
22 higher social ties and centrality, resulting in reverse causality that we cannot completely rule out
23 given the observational nature of the study. However, we include a set of socio-economic factors

1 that might have back-door influences on the mental health outcomes and we block those
2 influences by controlling them in all our empirical models. [37]

3 We are also limited by using GHQ-12 to measure mental health outcomes, which is not a
4 clinical tool and captures uni-dimensional unspecified psychological morbidity. [29] Hence, this
5 scale will only measure the true mental health status with some measurement errors. This will
6 limit total variation we will be able explain with our empirical models. We are also capturing,
7 while important, very specific types of social ties, namely friends within the community and a
8 specific age group. Obviously, our respondents can have social ties and network outside the
9 community and also through online social media. Such measurement errors will lead to
10 downward bias and smaller coefficients (in absolute terms), as one can observe in all our models.
11 So our estimates can be considered as lower bounds for the true effects of social ties on mental
12 well being of the respondents.

13 Despite these limitations, the findings presented here further enhance our understanding of
14 social network determinants of mental health for a very interesting population. The post-
15 adolescent young population is particularly important because, Bangladesh, like many low-
16 middle income countries of the world, remains and will remain largely young for another
17 generation or so. High youth unemployment and underemployment can put strain on men due to
18 traditional gender expectations. [38] In this context, isolation and social disconnectedness can
19 contribute to lower mental health luring male youth to violence, which has become a concern
20 locally in the recent time. Thus, our findings have important implications for understanding
21 mental health outcomes and policies addressing psychosocial health issues for young men and
22 highlight the importance of social connection and ties in determining mental health among post-
23 adolescent population in the context of developing countries.

1 Contributorship

2 AR1 and MS conceived the study. AR led the analysis with guidance from NRB, AR2 and
3 MS. NRB led the social network data collection and analyses with guidance from AR1. AR2
4 managed the overall data collection and preliminary analyses with guidance from AR1 and MS.
5 AR1 wrote the first draft and the final manuscript with contribution from MS. All authors have
6 seen and approved the final version of the manuscript.

7 Conflicts of interests

8 All authors declare no conflicts of interest.

9 Role of funding source

10 The study was funded by WOTRO Science for Global Development of Netherlands
11 Organization for Scientific Research (NWO) under grant number W 08,560.007. Funding source
12 did not play any role in designing of the study or collecting, analyzing or interpreting the data or
13 preparing this manuscript and deciding to submit the paper for publication.

14 Data sharing

15 All the data used in the preparation of this paper has been properly deidentified and no
16 personal identification information was retained in the final data sets. The data used in the paper
17 can be made available upon request and as per the policy of the journal.

18 Ethical approval

19 The Institutional Review Board at the BRAC School of Public Health, BRAC University
20 reviewed and approved both the proposal and the data collection protocols. All the participants
21 provided written informed consent prior to the survey. Data collectors at first explained the
22 research objective and the confidentiality that would be maintained after gathering the

1 information from the young men. Moreover, entirely voluntary nature of the participation in the
2 survey was carefully explained and the participant could withdraw himself at any point of the
3 survey even after signing the consent form. One copy of the written consent form was given to
4 the participant and another copy was retained for the official record.

5 **BIBLIOGRAPHY**

- 1 WHO. Mental disorders. [Internet]. 2017 [cited 2017 September 29]. Available from:
2 <http://www.who.int/mediacentre/factsheets/fs396/en/>.
- 3 Murray, et al. Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases
4 and injuries and healthy life expectancy (HALE) for 188 countries, 1990–2013: quantifying the
5 epidemiological transition. *The Lancet*. 2015;386(10009):2145 - 2191.
- 6 Vigo D, Thornicroft G, Atun R. Estimating the true global burden of mental illness. *The Lancet*
7 *Psychiatry*. 2016;3(2):171-178.
- 8 Steel Z, Marnane C, Iranpour C, Chey T, Jackson JW, Patel V, Silove D. The global prevalence of
9 common mental disorders: a systematic review and meta-analysis 1980–2013. *International*
10 *journal of epidemiology*. 2014;43:476-493.
- 11 Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, Charlson FJ, Norman RE,
12 Flaxman AD, Johns N, et al. Global burden of disease attributable to mental and substance use
13 disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*.
14 2013;382(9904):1575-1586.
- 15 Ferlander S. The importance of different forms of social capital for health. *Acta Sociologica*.
16 2007;50(2):115-128.

- 1
2
3 7 Lund C, Breen A, Flisher AJ, Kakuma R, Corrigall J, Joska JA, Swartz L, Patel V. Poverty and
4 common mental disorders in low and middle income countries: a systematic review. *Social science*
5 & medicine. 2010;71(3):517-528.
6
7
8
9
10 8 Andrade LH, Wang YP, Andreoni S, Silveira CM, Alexandrino-Silva C, Siu ER, Nishimura R,
11 Anthony JC, Gattaz WF, Kessler RC, et al. Mental disorders in megacities: findings from the Sao
12 Paulo megacity mental health survey, Brazil. *PloS one*. 2012;7(2):e31879.
13
14
15
16
17 9 Gronholm PC, Thornicroft G, Laurens KR, Evans-Lacko S. Mental health-related stigma and
18 pathways to care for people at risk of psychotic disorders or experiencing first-episode psychosis:
19 a systematic review. *Psychological Medicine*. 2017;47:1867–1879.
20
21
22
23
24 10 Baum FE, Ziersch AM. Social capital. *Journal of Epidemiology & Community Health*.
25 2003;57(5):320-323.
26
27
28
29 11 Webber M, Huxley P, Harris T. Social capital and the course of depression: six-month prospective
30 cohort study. *Journal of affective disorders*. 2011;129(1):149-157.
31
32
33
34 12 Fafchamps M, Lund S. Risk-sharing networks in rural Philippines. *Journal of Development*
35 *Economics*. 2003;71(2):261-287.
36
37
38
39 13 WHO. Review of Social Determinants and the Health Divide in the WHO European Region: Final
40 Report. Copenhagen: World Health Organization; 2008.
41
42
43
44 14 Graney MJ. Happiness and Social Participation in Aging. *Journal of Gerontology*. 1975 701-706.
45
46
47 15 Diener E, Seligman M. Very Happy People. *Psychological Science*. 2002.
48
49
50 16 Holder MD, Coleman B. The Contribution of Social Relationships to Children’s Happiness. *Journal of*
51 *Happiness Studies*. 2009 329-349.
52
53
54
55
56
57
58
59
60

- 1
2
3 17 Cobb S. Social support as a moderator of life stress. *Psychosomatic medicine*. 1976;38(5):300-314.
4
5
6 18 De Silva MJ, McKenzie K, Harpham T, Huttly SRA. Social capital and mental illness: a systematic
7
8 review. *Journal of epidemiology and community health*. 2005;59(8):619-627.
9
10
11 19 Fowler JH, Christakis NA. Dynamic spread of happiness in a large social network: longitudinal
12
13 analysis over 20 years in the Framingham Heart Study. *BMJ*. 2008;337:a2338.
14
15
16 20 Bassett E, Moore S. Social capital and depressive symptoms: the association of psychosocial and
17
18 network dimensions of social capital with depressive symptoms in Montreal, Canada. *Social
19
20 Science & Medicine*. 2013;86:96-102.
21
22
23 21 Berkman LF, Glass T, Brissette I, Seeman TE. From social integration to health: Durkheim in the new
24
25 millennium. *Social science & medicine*. 2000;51(6):843-857.
26
27
28 22 Fujiwara T, Kawachi I. A prospective study of individual-level social capital and major depression in
29
30 the United States. *Journal of Epidemiology and Community Health*. 2008;62(7):627-633.
31
32
33 23 Rosenquist JN, Fowler JH, Christakis NA. Social network determinants of depression. *Molecular
34
35 psychiatry*. 2011;16(3):273-281.
36
37
38 24 Gayen K, Raeside R. Social networks, normative influence and health delivery in rural Bangladesh.
39
40 *Social science & medicine*. 2007;65(5):900-914.
41
42
43 25 Horng L, Dutta NC, Ahmed S, Rabbani A, Luby S, Uddin MJ. Peer Networking to Improve
44
45 Knowledge of Child Health and Immunization Services Among Recently Relocated Mothers in
46
47 Slums of Dhaka, Bangladesh. *Open Forum Infectious Diseases*. 2016;3(S1):625.
48
49
50 26 Perkins JM, Subramanian SV, Christakis NA. Social networks and health: a systematic review of
51
52 sociocentric network studies in low-and middle-income countries. *Social Science & Medicine*.
53
54 2015;125:60-78.
55
56
57
58
59
60

- 1
2
3 27 Islam MN, Iqbal KF. Mental Health and Social Support. The Chittagong Univ. J. B. Sci.
4
5 2008;3(1&2):95-107.
6
7
8 28 Hossain MM, Siddique NEA, Habib MFB. Status of Marital Adjustment, Life Satisfaction and Mental
9
10 Health of Tribal (Santal) and Non-Tribal Peoples in Bangladesh: A Comparative Study. IOSR
11
12 Journal Of Humanities And Social Science (IOSR-JHSS). 2017;22(4):5-12.
13
14
15 29 Hankins M. The reliability of the twelve-item general health questionnaire (GHQ-12) under realistic
16
17 assumptions. BMC public health. 2008;8(1):355.
18
19
20 30 Marsden PV. Recent developments in network measurement. In: Carrington PJ, Scott J, Wasserman S.
21
22 Models and methods in social network analysis. Cambridge University Press; 2005. p. 8-30.
23
24
25 31 Bonacich P. Power and Centrality: A Family of Measures. American Journal of Sociology. 1987 1170-
26
27 1182.
28
29
30 32 Jackson MO. Social and economic networks. Princeton university press; 2010.
31
32
33 33 Chakraborty NM, Fry K, Behl R, Longfield K. Simplified asset indices to measure wealth and equity
34
35 in health programs: a reliability and validity analysis using survey data from 16 countries. Global
36
37 Health: Science and Practice. 2016;4(1):141-154.
38
39
40 34 Wooldridge JM. Econometric analysis of cross section and panel data. Cambridge (MA): The MIT
41
42 Press; 2002.
43
44
45 35 BBS. Household Income and Expenditure Survey, 2010. Dhaka, Bangladesh: Bangladesh Bureau of
46
47 Statistics; 2011.
48
49
50 36 Krabbendam L, Os JV. Schizophrenia and urbanicity: a major environmental influence—conditional
51
52 on genetic risk. Schizophrenia bulletin. 2005;31(4):795-799.
53
54
55
56
57
58
59
60

1
2
3 37 Pearl J. Causality. Cambridge university press; 2009.
4
5

6 38 Economist Intelligence Unit. High university enrolment, low graduate employment Analysing the
7 paradox in Afghanistan, Bangladesh, India, Nepal, Pakistan and Sri Lanka. [Internet]. 2014 [cited
8 2015 Jun 12]. Available from: <http://goo.gl/sVKaD9>.
9
10
11
12

13 1
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

1
2
3 **Figure 1: Distribution of GHQ-12 scores**
4
5

6 2 Notes. Based on 824 respondents. Here we report the non-standardized GHQ scores. The mean is shown as the
7 3 vertical red line and the median is shown as the vertical blue line. GHQ is the aggregate of 12 questions with
8 4 possible values of 0, 1, 2 and 3. The scores of all 12 questions are added to measure the composite score for a
9 5 respondent.

10 6
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

1
2
3 **1 Figure 2: Visualization of the friendship network of the 824 young men of Vashantek**
4
5
6

7 2 Notes: Here we show the socio network graph for 824 respondents. Each node represents an individual respondent.
8 3 The connector shows the friendship ties between two respondents. There are 267 respondents who are completely
9 4 isolated (not included in the figure). The largest component consists of 450 respondents who are all connected with
10 5 each other through intermediate ties. We also have 37 smaller components with smaller networks.
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

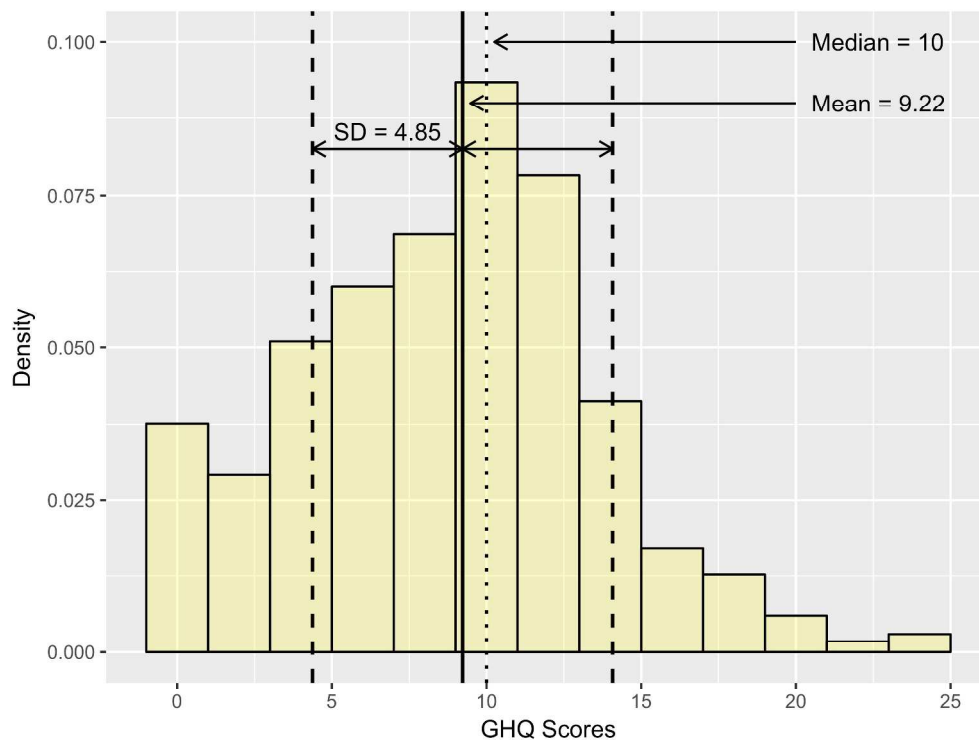


Figure 1: Distribution of GHQ-12 scores

325x243mm (300 x 300 DPI)

Peer Review Only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

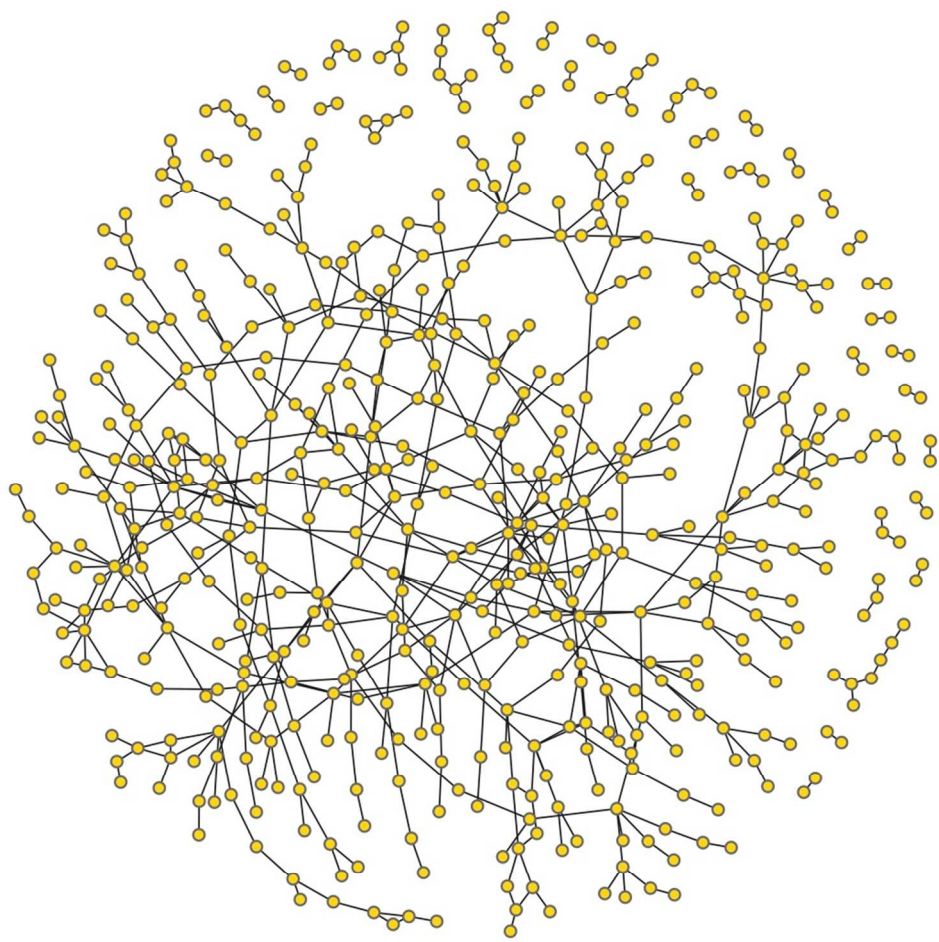


Figure 2: Visualization of the friendship network of the 824 young men of Vashantek

1 **A social network analysis of psychological morbidity in an urban slum of Bangladesh: a**
 2 **cross-sectional study based on a community census**

3 **APPENDIX A: DETAILED ITEM ANALYSES OF GHQ-12**

4 Here we present the detailed item-wise report from the Generalized Health Questionnaire we
 5 have implemented among our respondents (see Appendix Table 1). We have used a version of
 6 the GHQ-12 that has been previously translated and adopted in Bangladeshi context (Hossain,
 7 Siddique and Habib 2017, Islam and Iqbal 2008).

8 **Appendix Table 1: GHQ-12 Responses by Each Item**

	Reponses (fraction of total)				Mean	95% CI	
	Never	Sometimes	Often	Always			
	0	1	2	3			
Have you recently been able to; concentrate on what you are doing?	0.347	0.489	0.157	0.007	0.824	0.776	0.872
Have you recently lost much sleep over worry?	0.417	0.485	0.085	0.012	0.692	0.646	0.738
Have you recently felt you were playing important part in things?	0.369	0.468	0.159	0.004	0.797	0.749	0.846
Have you recently felt capable of making decisions about things?	0.214	0.567	0.211	0.008	1.015	0.968	1.061
Have you recently felt consistently under strain?	0.280	0.511	0.184	0.024	0.953	0.901	1.004
Have you recently felt you couldn't overcome your difficulties?	0.227	0.552	0.205	0.016	1.010	0.962	1.058
Have you recently been able to enjoy your normal day to day activity?	0.291	0.522	0.180	0.007	0.903	0.855	0.951
Have you recently been able to face up to your problems?	0.209	0.542	0.242	0.007	1.047	1.000	1.095
Have you recently been unhappy and depressed?	0.471	0.453	0.069	0.007	0.613	0.569	0.657
Have you recently been losing confidence in yourself?	0.715	0.221	0.028	0.036	0.386	0.337	0.435
Have you recently been thinking of yourself as a worthless person?	0.733	0.237	0.017	0.013	0.311	0.271	0.350
Have you recently been feeling reasonably happy, all things considered?	0.451	0.437	0.097	0.015	0.675	0.626	0.723
Overall GHQ-12					9.225	8.893	9.556

1
2
3 1 There are two suggested methods of scoring for GHQ-12. We have used the ‘four point
4
5 2 response scale’ or Likert method, which should allow more variation in the scores (see Hankins
6
7 3 2008). GHQ-12 typically captures the unidimensional nature of unspecified psychological
8
9 4 morbidity and commonly used in survey based instruments to measure the mental wellbeing in
10
11 5 different populations.
12
13
14

15 **APPENDIX B: CENTRALITY MEASURES**

16
17

18 7 While intuitive, just focusing on the number of friendship ties can mask the deeper structure
19
20 8 of social power or popularity within a network. We focus on a number of more sophisticated
21
22 9 measures of centrality which gauge one’s position in the entire network by analyzing not just the
23
24 10 number of people they are connected to but also the type of people they are connected to and
25
26 11 reveals to what extent that person is central/peripheral in his social network by analyzing their
27
28 12 network positions (Freeman 1978). While ‘node degree’ shows the extent of connectedness,
29
30 13 centrality shows how well and centrally each node is connected and we focus on a number of
31
32 14 them.
33
34
35
36

37 *Degree Centrality*

38

39 16 Degree centrality is simply the number of degrees each person has. In-degree centrality is the
40
41 17 number of referrals each person gets, out-degree centrality is the number of referrals each person
42
43 18 gives and all-degree centrality is the number of total referrals (summing both the referrals he
44
45 19 gives and the ones he gets). Hence, degree centrality is just the number of friendship ties each
46
47 20 respondent has normalized by the possible total number of ties ($N - 1$).
48
49
50

51 *Closeness Centrality*

52

53 22 Closeness centrality is the inverse of the average distance within a network. It measures how
54
55 23 distant a node is from the rest of the nodes and how many times it has to be crossed by other
56
57
58
59

1 nodes to reach some other node using the shortest path. Applying this in the context of our
 2 friendship network, we can measure how many stages a person requires to get connected to
 3 another random person or node in the network.

$$\text{Closeness Centrality}_i = \frac{n - 1}{\sum_{j \neq i} l(i, j)}$$

4 where, $l(i, j)$ denotes the number of links node i needs to reach to node j using the shortest path.
 5 Input closeness centrality and output closeness centrality take into account of the direction of
 6 referral while all closeness centrality does not.

7 *Betweenness Centrality*

8 Betweenness centrality is a measure of centrality based on how well situated a person is in
 9 terms of the paths he lies on (see Freeman 1978, Jackson 2010). This takes into account the
 10 number of shortest links connecting each node to all other nodes that pass through a particular
 11 node.

12 Let $P_i(j, k)$ denote the number of shortest paths between any two nodes j and k that pass
 13 through node i and, let $P(j, k)$ represent the number of shortest paths between these two nodes .
 14 Then,

$$\text{Betweenness Centrality}_i = \sum_{k \neq j, k, j} \frac{P_i(k, j)/P(k, j)}{(n - 1)(n - 2)/2}$$

15 where, n is total number of nodes. So in short, betweenness centrality of a node is equal to the
 16 number of geodesics passed through that particular node divided by the number of all the
 17 geodesics of any two other nodes.

1 *Eigenvector Centrality*

2 Eigenvector centrality measures a person's centrality based on the centrality of his direct
3 connections. Letting $C^e(g)$ denote the eigenvector centrality associated with a network g , then
4 the centrality of a node is proportional to the sum of the centrality of its neighbors. So,
5 eigenvector centrality, $\tau C_j^e(g) = \sum_i g_{ij} C_i^e(g)$. And in terms of matrix, $\tau C^e(g) = g C^e(g)$ where
6 $C^e(g)$ is an eigenvector of g and τ is the corresponding eigenvalue.

7 Eigenvector centrality is a better measure of social prestige as it takes account of the position
8 of the direct friends of each person (Bonacich, 2007). As a result, a person having very few but
9 centrally positioned friends will not be under-estimated to a person having a lot of almost
10 isolated or peripherally positioned friends. Eigenvector centrality is closely related to Bonacich
11 centrality and is a variant of Bonacich centrality. They are also used as a proxy for each other
12 (Bonacich, 1987, Bonacich, 1991).

13 **APPENDIX C: ROBUSTNESS CHECKS**

14 To test the validity of our statistical findings, we carry out some additional robustness checks
15 to see whether our estimates are sensitive to the models we have determined. The results are
16 presented in Appendix Table 2. We first restrict our models by dropping the 267 isolated
17 respondents. It is possible that our centrality measures can pick up the outcome differences
18 between these two groups. However, results in row (1) of Appendix Table 2 suggest this is not
19 the case. The estimate on the sub-sample is -0.098 (95% CI -0.151 to -0.044), which is very
20 similar to the value we found in column (4) in Table 3. The estimated coefficient on betweenness
21 centrality is not sensitive to excluding the isolated nodes. We also find that betweenness
22 centrality has too many zeros, hence, we define a dummy for respondents with non zero values
23 and re-estimate the model. We find negative association between mental health outcomes of the

1 respondents and those with non-zero betweenness centrality (-0.163, 95% CI -0.321 to -0.004,
 2 see row [2]). The results are very similar for eigenvector centrality as well (see rows [3] and [4]
 3 in Appendix Table 1). We also use a new measure of being influential within a network namely
 4 input proximity prestige index. We find that one SD higher value in this index is associated with
 5 0.06 SD lower GHQ score (95% CI -0.124 to 0.010, see row [5]), suggesting better mental health
 6 outcomes.

7 **Appendix Table 2: Robustness Checks**

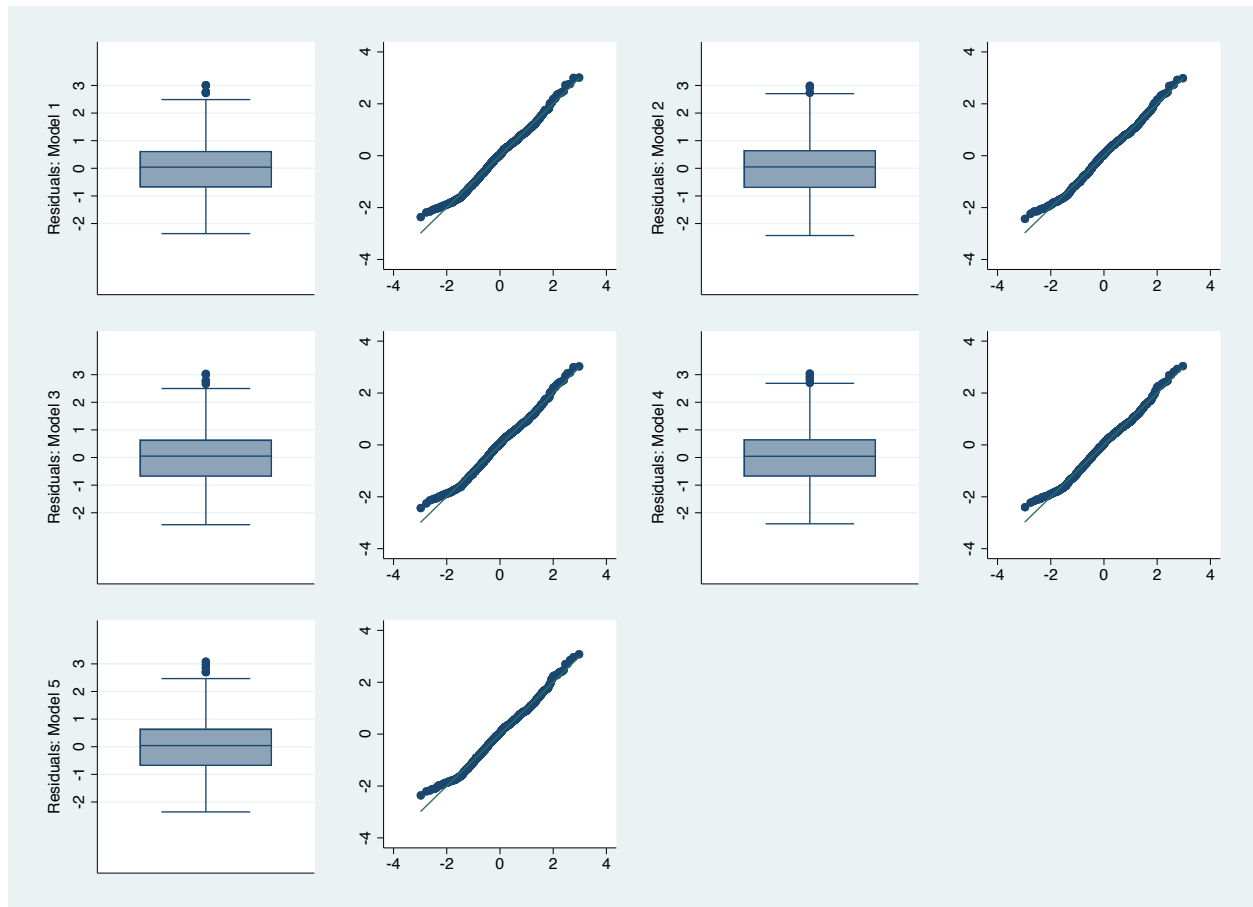
		Coefficient	(95% CI)	N	R ²
(1)	Betweenness Centrality (standardized) excluding isolated respondents	-0.098***	(-0.151 to -0.044)	557	0.058
(2)	= 1 if Betweenness Centrality > 0	-0.163**	(-0.321 to -0.004)	824	0.038
(3)	Eigenvector Centrality (standardized) excluding isolated respondents	-0.060***	(-0.098 to -0.023)	557	0.051
(4)	= 1 if Eigenvector Centrality > 0	-0.117	(-0.257 to 0.023)	824	0.037
(5)	Input Proximity Prestige (standardized)	-0.057*	(-0.124 to 0.010)	824	0.036
Results from ordered probit models					
(6)	All closeness centrality (standardized)	-0.052	(-0.124 to 0.019)	824	
(7)	Betweenness centrality (standardized)	-0.106***	(-0.177 to -0.034)	824	
(8)	Eigenvalue centrality (standardized)	-0.064*	(-0.133 to 0.006)	824	

8 Note: The outcome variable is the standardized GHQ score in all specifications. In specifications (1) and (3), we
 9 drop the respondents who do not have any friendship tie. In specifications (2) and (4), we use an indicator variable
 10 for respondents with non-zero centrality values. In specifications (6-8), we use ordered probit models for the discrete
 11 standardized GHQ score as the outcome variables. In all specifications, we have retained the control variables that
 12 we include in Table 3. The robust p-values are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

13 As we noted earlier, GHQ scores are essentially discrete in nature and we could actually
 14 reject null hypothesis of normality distribution in GHQ scores. So we have re-estimated the
 15 models with three centrality scores using ordered probit models and relaxed the normality
 16 assumption in the outcome variables. The results are presented in rows (6-8). We find that both

1 the point estimates and also the second moments are generally not sensitive to the alternative
 2 regression models.

3 Appendix Figure 1: Testing for Outliers in Residuals and QQ Plots



4 Note: In each panel, on the left we plot the box-plot for the residuals from each model reported in Table 3.
 5 On the right, we show the QQ plots for the same residuals.

6 APPENDIX D: DIAGNOSTIC TESTS FOR REGRESSION RESULTS IN TABLE 3

7 We present some diagnostic tests for the basic Gauss-Markov assumptions here (see
 8 Wooldridge 2002). Our outcome variable is discrete in nature so it is important test for
 9 normality. We also check for outliers in our models. We box plot the residuals for all five models
 10 from Table 3 and also plot the QQ chart to visually inspect the distributions for the residuals
 11 from the same models. We present the charts in different panels in Appendix Figure 1.

1 Simple visual inspections suggest there are few outliers in the residuals from all five models;
 2 however, the frequency does not warrant much concern. We also look at the quintile normal
 3 figures and residuals generally lie on the lines. While they may suggest that misspecifications
 4 may not be an issue we further use statistical tests to check the normality of the residuals. We
 5 show the results in Appendix Table 2.

6 **Appendix Table 2: Normality Tests**

Model	p-value	
	Shapiro-Wilk	Shapiro –Francia
1	0.00041	0.00121
2	0.00077	0.00213
3	0.00059	0.00163
4	0.00062	0.00172
5	0.00042	0.00119

7 Note. We report the p-values from Shapiro-Wilk and Shapiro-Francia tests
 8 for residuals from each model reported in Table 3.

9 The normality tests reported in Appendix Table 2 suggest that in all five models null of
 10 hypotheses of normality are rejected. Hence, we carry out further robustness checks with
 11 alternate specifications as reported in Appendix D below.

12 BIBLIOGRAPHY

13 Bonacich, Phillip. "Power and Centrality: A Family of Measures." *American Journal of*
 14 *Sociology*, 1987: 1170-1182.

15 Bonacich, Phillip. "Simultaneous group and individual centralities." *Social networks* 13, no.
 16 2 (1991): 155-168.

17 Bonacich, Phillip. "Some unique properties of eigenvector centrality." *Social networks* 29,
 18 no. 4 (2007): 555-564.

1
2
3 1 Freeman, Linton C. "Centrality in social networks conceptual clarification." *Social Networks*
4
5 2 1, no. 3 (1978): 215-239.
6
7

8 3 Hossain, Md. Mobarak, Nur-E-Alam Siddique, and Murshida Ferdous Binte Habib. "Status
9
10 4 of Marital Adjustment, Life Satisfaction and Mental Health of Tribal (Santal) and Non-Tribal
11
12 5 Peoples in Bangladesh: A Comparative Study." *IOSR Journal Of Humanities And Social Science*
13
14 6 (*IOSR-JHSS*) 22, no. 4 (2017): 5-12.
15
16
17

18 7 Islam, Md. Nurul, and Kazi Ferdous Iqbal. "Mental Health and Social Support." *The*
19
20 8 *Chittagong Univ. J. B. Sci* 3, no. 1&2 (2008): 95-107.
21
22

23 9 Wooldridge, Jeffrey M. *Econometric analysis of cross section and panel data*. Cambridge,
24
25 10 MA: The MIT Press, 2002.
26
27

28 11
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	N/A
		(c) Explain how missing data were addressed	N/A
		(d) If applicable, describe analytical methods taking account of sampling strategy	8
		(e) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-11
		(b) Indicate number of participants with missing data for each variable of interest	N/A

Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-13
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	See Appendix
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

A social network analysis of psychological morbidity in an urban slum of Bangladesh: a cross-sectional study based on a community census

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-020180.R2
Article Type:	Research
Date Submitted by the Author:	30-Mar-2018
Complete List of Authors:	Rabbani, Atonu; Dhaka University, Department of Economics; BRAC University James P Grant School of Public Health, Biju, Nabila; BRAC University James P Grant School of Public Health, Rizwan, Ashfique; BRAC University James P Grant School of Public Health, Sarker, M; BRAC University James P Grant School of Public Health, ; Institute of Public Health
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Global health, Sociology, Public health
Keywords:	MENTAL HEALTH, PUBLIC HEALTH, Social Network, Social Determinants

SCHOLARONE™
Manuscripts

1
2
3 1 **A social network analysis of psychological morbidity in an urban slum of Bangladesh: a**
4
5 2 **cross-sectional study based on a community census**
6
7

8 3 Atonu Rabbani^{a,*}, Nabila Rahman Biju^b, Ashfique Rizwan^c, Malabika Sarker^d
9
10

11 4
12 5 ^aDepartment of Economics, University of Dhaka, Dhaka 1000, Bangladesh & BRAC School of
13 6 Public Health, 5th Floor, (Level-6), icddr,b Building, 68 ShahidTajuddin Ahmed Sharani,
14 7 Mohakhali, Dhaka-1212, Bangladesh. Email: atonu.rabbani@gmail.com,
15 8 atonu.rabbani@econdu.ac.bd
16 8

17 9 ^bBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 Shahid Tajuddin
18 10 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh. Email: nabila.rahman@bracu.ac.bd

19 11 ^cBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 ShahidTajuddin
20 12 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh. Email: ashfique.rizwan@bracu.ac.bd

21 13 ^dBRAC School of Public Health, 5th Floor, (Level-6), icddr,b Building, 68 ShahidTajuddin
22 14 Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh & Institute of Public Health,
23 15 ImNeuenheimer Feld 130.3, MarsiliusArkaden - 6. Stock, 69120 Heidelberg, Germany. Email:
24 16 malabika@bracu.ac.bd
25 16
26 17
27 18
28
29
30
31
32
33

34 19 ***Corresponding Author:**
35
36

37 20 Atonu Rabbani
38 21 Associate Professor
39 22 Department of Economics
40 23 University of Dhaka
41 24 Dhaka 1000, Bangladesh
42 25 Email: atonu.rabbani@gmail.com
43 26 Phone: +8801730441787
44 27

45 28 **Word Count:**
46
47
48

49 29 Paper – 3,929 (3,350 without tables and figure placement texts)
50
51

52 30 Abstract – 225
53
54
55 31
56
57
58
59
60

Abstract

Objectives To test whether social ties play any roles in mitigating depression and anxiety, as well as in fostering mental health among young men living in a poor urban community.

Setting A cohort of all young men living in an urban slum in Dhaka, the capital of Bangladesh.

Participants All 18- to 29-year-old men (N = 824) living in a low-income urban community at the time of the survey.

Primary and secondary outcome measures Unspecified psychological morbidity measured using the Generalized Health Questionnaire (GHQ-12), where lower scores suggest better mental status.

Results The GHQ scores (mean = 9.2, SD = 4.9) suggest a significant psychological morbidity among the respondents. However, each additional friend is associated with a 0.063 SD lower GHQ score (95% CI -0.106 to -0.021). Between centrality measuring the relative importance of the respondent within his social network is also associated with a 0.103 SD lower GHQ score (95% CI -0.155 to -0.051), as are other measures of social network ties. Among other factors, married respondents and recent migrants also report a better mental health status.

Conclusions Our results underscore the importance of social connection in providing a buffer against stress and anxiety through psychosocial support from one's peers in a resource-constrained urban setting. Our findings also suggest incorporating a social network and community ties in designing mental health policies and interventions.

Keywords: Mental health status, social network, young men, urban slum

1 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 2 • Our analyses take advantage of a census of young men in a resource-constraint low-income
3 urban community in Bangladesh to establish the roles a social network and community ties
4 play in determining better mental health outcomes.
- 5 • The measurement of the social network is based on a roster-based approach where friendship
6 connections for all possible pairs of respondents are carefully assessed and validated.
- 7 • We take advantage of a locally adopted GHQ-12 to assess unspecified mental health
8 outcomes along with detailed socioeconomic characteristics of our respondents.
- 9 • Cross-sectional data limit causal interpretations and cannot rule out the reverse causality of
10 otherwise robust relationships, and community ties through friendships can capture only
11 limited aspects of the respondents' social network.

1 INTRODUCTION

2 Mental illness and disorders refer to “abnormal thoughts, perceptions, emotions, behaviour,
3 and relationships with others.” [1] Mental illness contributes about 7.1 percent to global disease
4 burden, and the cost of mental disorders such as depression can be enormous. [2,3] Over a
5 person’s lifetime, psychological disorders can adversely affect one-third of the global population.
6 [4] As of 2010, close to 900 million people were estimated to suffer from certain mental health
7 issues, including depression, anxiety, and substance abuse. [5] The burden of mental health is
8 also likely to increase with growing urbanization in developing countries. [6,7] Poor
9 neighborhoods and low-income communities potentially offer more stressful environments for
10 urban citizens. [8] Hence, one can infer that a larger share of the global mental health burden will
11 be borne by lower-income populations living in challenging environments in newly urbanized
12 developing nations. This is further compounded by the social stigma and general misinformation
13 associated with mental health symptoms, resulting in low psychosocial care seeking in
14 developing countries. [9]

15 Social capital can be multifaceted, and its definitions vary in the literature as they aim to
16 capture the different aspects of social engagements for an individual. [10] Social capital
17 encompasses civic engagement, trust, reciprocity, and certain norms. Moreover, it can both be a
18 structural feature of the community or group and be owned by an individual to rely on and
19 exploit to command over resources to ensure his or her well-being. [11,12] The horizontal nature
20 of ties, for example, friendship network and community embeddedness, is considered a defining
21 feature of one’s social capital, and prior literature typically associates resulting social capital
22 with socially desirable health outcomes. [13]

1 A growing consensus reveals that the quality of social ties and deeper social embeddedness
2 are important determinants of mental health. [14,15,16] Lack of social ties has been found to be a
3 risk factor for some mental health indicators. [17,18,19,20] By ensuring attachment and buffer, a
4 social network and community ties can have both extrinsic and intrinsic values for an
5 individual's mental or psychological well-being. [21] Prior studies have shown the positive roles
6 social connection can play in lowering depressive episodes. [20,22] Depressive symptoms are
7 also less likely to manifest in people who are more central within the group they belong. [23]
8 Mental state of mind, like happiness, can also better in people with social networks that are
9 closer in terms of geographical distance. [19]

10 In the context of Bangladesh, social networks have been found to contribute to health service
11 delivery in both rural and urban areas. [24,25] However, we have limited information on how
12 social ties and network properties can determine mental health outcomes in urban Bangladesh
13 and similar other low-income contexts. One's social network has been found to have a strong
14 association with positive mental health outcomes. However, these studies have been conducted
15 mostly in developed countries by taking advantage of large, often longitudinal, cohort studies
16 and population level data. [19,20,22,23] We intend to contribute to the growing literature on
17 social network as a determinant of mental health by exploiting a community-level census of
18 young men in a slum in Dhaka.

19 **METHOD**

20 **Study Design**

21 We followed a cross-sectional study design based on individual respondents from a census of
22 young men living in an urban slum at the time of the survey (N = 824). The census allowed us to

1 enumerate friendship ties along with directions between any two respondents among possible
2 339,076 ties. We also collected mental health outcome measures along with the detailed
3 socioeconomic characteristics of the respondents.

4 **Study Setting**

5 We conducted our study in a particular but otherwise typical urban community in Dhaka,
6 namely, Vashantek. The entire Vashantek slum was geographically divided into four
7 subdivisions with a total population of around 31,000 or about 5,500 households. We chose to
8 work in a particular subdivision and conducted a census of all men aged between 18 and 29
9 years. The study was part of a larger project, which focused on gender norms, risky sexual
10 behavior, and mental health within this particular population. These topics often focused on
11 adolescent or female populations. Hence, we chose post-adolescent young men in a low-income
12 urban community as the study population to provide some novel and unique perspectives to the
13 relevant literature. We collected baseline information on a number of socioeconomic variables
14 and detailed social network information on all the targeted respondents. The site and the setting
15 met the necessary criteria for usual social network analyses. [26]

16 **Sample and Sampling Technique**

17 We collected information on all men aged between 18 and 29 in our targeted site. Initially,
18 we listed all the households in the study community with men who fit the age criteria. We asked
19 each household whether an 18- to 29-year-old man lived in that household. We followed up with
20 their full names, contact information, and availability for a more detailed survey afterward. We
21 found a total of 942 potential respondents from 790 households through this initial listing
22 process. After thoroughly training the data collectors and pretesting the questionnaire, we sent
23 nine data collectors to conduct the surveys. We used skilled enumerators who had prior

1 experience in a mobile-based quantitative survey through SurveyCTO. The enumerators
2 conducted the interviews in 26 days during the month of December 2016.

3 We collected demographic, economic, sexual practice, and friendship information using a
4 structured questionnaire. We excluded some of the respondents who moved out of the slum
5 between the initial household listing and the follow-up survey. We also found households that
6 had a potential respondent who lived outside the community but was previously listed as a
7 household member. We also excluded individuals with communication impairments and two
8 respondents who refused to provide a written consent. The final cohort consisted of 824 young
9 men aged 18 to 29 years living in our study area. We performed all analyses on this sample.

10 **Patient and Public Involvement Statement**

11 No patients were involved in designing the study or developing the research questions, nor
12 were they involved in analyzing or interpreting the findings. The study was conducted on a
13 community-based sample of individuals who met the pre-specified criteria. We would discuss
14 some of the general implications of the study findings through workshops as well as through a
15 series of radio shows to help address mental health problems affecting young men in Dhaka.

16 **Measures of Mental Well-Being**

17 We used the 12-question version of the General Health Questionnaire (GHQ-12), an often-
18 used survey-based tool that measures the population morbidity of nonpsychotic and minor
19 psychiatric disorders, to assess the mental well-being of individuals, where a higher score
20 generally suggests a poor mental health outcome. GHQ-12 was implemented and validated
21 widely in different contexts in both developed and developing countries, including Bangladesh.
22 [27,28] Because of its precise and concise nature and validity in the context of Bangladesh, we
23 considered this tool to be appropriate for our study to assess any nonspecific psychiatric

1 morbidity among the respondents. [29] We estimated Cronbach's α , and a value of 0.83 suggests
2 high internal consistency. We further performed exploratory factor analysis, and high individual
3 variance for each factor suggested high reliability of the score in our sample. The detailed item-
4 wise responses are reported in Appendix A.

5 **Social Network Analysis (SNA) Parameters**

6 For the social network analysis, we asked each respondent to name his close friend(s) in the
7 community and state where they lived (particular landmark/household identifier in the slum).
8 After confirming the proper identification of all the close friends mentioned by the respondents,
9 we constructed a 824×824 square *sociomatrix* showing direct friendship ties with a value of 1
10 or 0. [30] We then used the network analysis software Pajek to analyze the data set. We
11 estimated different social network parameters for each of our respondents to measure the
12 embeddedness and centrality of each respondent within the friendship network. These measures
13 captured richer aspects of the social network of the respondents (for definitions of the different
14 social network parameters, see Appendix B). [31,32] For robustness check and sensitivity
15 analyses, we used nonlinear versions of some of our centrality measures because of the
16 overrepresentation of zeros in our sample, which indicates the absence of any ties between
17 individuals. [20] We also estimated some additional measures of the nature of the social network
18 at individual levels to perform further sensitivity analyses (see Appendix C).

19 **Socioeconomic Characteristics**

20 Given the observational nature of our study, we controlled for various socioeconomic
21 characteristics of the respondents. These factors could potentially confound our results, and we
22 included them all in our multivariable analyses. Some of these factors were also important and
23 can capture community embeddedness and social support aspects of a person's life that could

1 influence psychosocial well-being, such as marital status and birth in the same community. We
 2 further collected information on the age of the respondent as well as his education and current
 3 occupation. We also profiled the wealth status of the respondent's households. We used a wealth
 4 index called Equity Tool, which generated comparable results across different contexts. [33] This
 5 tool was validated for Bangladesh and consists of seven questions in its latest update as of 2014.
 6 We chose the urban wealth scores and urban wealth quintile for our study.

7 **Statistical Analyses**

8 To assess the relationship between mental well-being and social ties, we ran different
 9 regression models with different social network measures. We included the socioeconomic
 10 characteristics in all the regression models and separately analyzed the coefficients on these
 11 additional controls. For the multivariable analyses, we used robust regression models to correct
 12 the possible violation of the standard Gauss-Markov assumptions (see Appendix D). [34] We
 13 standardized both the mental health outcomes and the continuous variables on the right-hand side
 14 in the regression models and estimated the beta-coefficients. We further used ordered probit
 15 analyses for some additional robustness checks (see Appendix C). In the outcome variable,
 16 GHQ-12 scores were discrete in nature and hence were prone to violation of the basic normality
 17 conditions. Ordered probit models relaxed these assumptions (see Appendixes C and D). All
 18 econometric analyses were performed using StataTM/MP 15.0.

19 **Table 1: Summary Statistics**

	Mean (SD)
Age, years	23.6 (3.6)
Currently Married, percent	52.2 (50.0)
Born in <i>Vashantek</i> , percent	44.2 (49.7)

Education, percent	
No formal education	83 (10.1)
Primary incomplete	290 (35.2)
Primary complete	106 (12.9)
Secondary incomplete	206 (25.0)
Secondary complete/Above	139 (16.9)
Equity Score	-0.016 (0.230)
Wealth Quintile, percent	
First	61 (7.4)
Second	325 (39.4)
Third	418 (50.7)
Fourth	16 (1.9)
Fifth	4 (0.5)
Occupations, percent	
Driver	138 (16.8)
Service Sector	125 (15.2)
Student	109 (13.2)
Business/Shop owner	100 (12.1)
Construction worker/Carpenter/Wall painter	88 (10.9)
Daily labor	58 (7.0)
Rickshaw puller/Van puller	43 (5.2)

Notes: Based on surveys of 824 respondents. Equity index is based on ownership of selected assets (namely, refrigerator, TV, almirah/wardrobe and electric fan) and household building materials. The wealth quintiles are based on equity scores with Bangladesh urban specific cutoffs. For occupations, "other" category is not included in the table.

6 FINDINGS

7 Socioeconomic Characteristics

8 We present the basic socioeconomic and demographic characteristics of the respondents in
 9 Table 1. The average age of the respondents is 24, with an SD of 3.6. About 44 percent of the
 10 respondents report living in the study community since birth. Interestingly, 52 percent of the
 11 respondents are married at the time of the survey. The respondent group also has low educational
 12 level as 45 percent report that they have achieved either not the primary educational level or
 13 lower. Their average schooling is about the same as those found in nationally representative
 14 household surveys. [35]

1 According to the generalizable equity score, with a mean of -0.016 and SD of 0.230, majority
2 of our respondents come from second and third wealth quintiles, with very few (only 2.5 percent)
3 from the top 2 wealth quintiles. We find a considerable variation in occupations that the
4 respondents are engaged in, namely, driving, service in construction sectors, and running small
5 businesses. About 13 percent of the respondents report being students at tertiary-level
6 educational institutions.

7 **Mental Health Status**

8 We present both distribution and summary statistics for the mental health status of the
9 respondents in Figure 1. We have found a considerable variation in GHQ-12 outcomes, which
10 range from 0 to 25. The average GHQ-12 score is about 9.2 with an SD of 4.9. We have further
11 assessed for normality using the Shapiro-Wilk test, and the results reject the null hypothesis of
12 normality. This result is natural given the discrete nature of GHQ-12 scoring, and we have
13 further tested the robustness of our results using an ordered probit model that takes into account
14 the discrete nature of our scoring (see Appendix C).

15 [FIGURE 1 ABOUT HERE]

16 **Social Network Analyses**

17 A visual inspection of the social network suggests that the respondents can belong to one of
18 the three broad types of components (see Figure 2): the largest component (N = 452 or 55
19 percent), 37 smaller self-contained components with sizes between 2 to 7 friends (N = 105 or 13
20 percent), and 267 respondents (32 percent) who have not mentioned anybody in the community
21 as a friend, or nobody in the community has mentioned them as a friend (see Table 2). They are
22 entirely isolated individuals in our target population with zero friendship ties in the community.

1 On average, our sample has 1.6 ties per respondent, including those who have reported no
2 friendship tie in the community.

3 **Table 2: Social Network Characteristics of the Respondents**

	Mean	SD
Respondents in each component, percent		
Large connected group	54.6	
Smaller groups	12.7	
Isolated with no referrals in any direction	32.4	
Number of friends, percent		
0	32.4	
1	26.3	
2	17.1	
3	11.0	
4	6.4	
5	3.9	
6 or more	2.8	
Average number of friendship ties	1.6	1.6
Average Centrality Scores		
Closeness centrality	0.034	0.031
Betweenness centrality	0.00000662	0.000024
Eigenvector centrality	0.004	0.034

4 Notes: Based on 824 respondents. Each respondent reports the friendship ties within the
5 community. The large connected group includes the biggest component where all subjects are
6 connected with intermediate ties. Centrality measures are estimated using Pajek.

7 The average closeness centrality score is 0.034 for this network of 824 men (with an SD of
8 0.031, see Table 2). The average betweenness centrality score for this network of 824 men is 6.6
9 $\times 10^{-6}$ (with an SD of 24.0×10^{-6}) with an overall betweenness centralization of 0.0003. We
10 further estimate the average eigenvector centrality for the respondents, which is equal to 0.004
11 (with an SD of 0.034). The overall eigenvector centralization of the network is 0.0071. An
12 average eigenvector (Bonacich power) centrality of 0.004 suggests that, on average, men in this
13 network do not hold very prestigious positions with fairly low variation.

14 [FIGURE 2 ABOUT HERE]

1 Association between Mental Well-Being and Social Networks

2 The results from our multivariable regression analyses, which assess the association between
3 mental health outcome (standardized GHQ scores) and individuals' social network parameters,
4 are presented in Table 3. All the continuous variables are standardized. In column 1 of Table 3,
5 we find that compared with an isolated respondent with no community friendship tie, a
6 respondent belonging to a small component has a 0.098 SD lower GHQ score (95% confidence
7 interval [CI] -0.327 to 0.131). Moreover, a respondent belonging to the larger component has a
8 0.117 SD lower GHQ score (95% CI -0.274 to 0.041).

9 In the next model in column 2 of Table 3, we find that mental health outcomes are
10 systematically better with higher degrees of ties or number of friends. Having an additional
11 friend is associated with a 0.063 SD lower GHQ score (95% CI -0.106 to -0.021). In the next
12 three columns, we include different measures of centralities that retain all the controls. We find
13 that a 1 SD higher all-closeness centrality score of a respondent is associated with a 0.053 SD
14 lower GHQ score (95% CI -0.124 to 0.018, see column 3 in Table 3). We find similar results for
15 betweenness and eigenvalue centralities. Respondents with a 1 SD higher betweenness centrality
16 score report about a 0.103 SD lower GHQ score (95% CI -0.155 to -0.051), and respondents with
17 a 1 SD higher eigenvalue centrality score report about a 0.068 SD lower SHQ score (95% CI -
18 0.103 to -0.033), controlling for other factors.

19 In all the five specifications, we include the socioeconomic characteristics of the respondents
20 as controls or possible confounding factors. The association between mental health outcomes and
21 other covariates is quite suggestive. We find that mental health worsens with age, about 0.012
22 SD higher with each additional year; however, while the point estimates are quite robust across
23 different models, they are not very precise. More educated respondents report a lower GHQ

1 score, so more educated respondents typically have better mental health status. Interestingly,
 2 respondents born in the community have better mental health status. Respondents who are
 3 currently married have 0.17–0.20 SD lower GHQ scores, and coefficient values are typically
 4 significant. We also find higher wealth as measured by the equity score, which is associated with
 5 a lower GHQ score or better mental health status.

6 **Table 3: Multivariable Association between Mental Health Outcomes and Social Network**

	(1)	(2)	(3)	(4)	(5)
Component type					
Disconnected	Base				
Small	-0.098 (-0.327 to 0.131)				
Large	-0.117 (-0.274 to 0.041)				
Number of friend(s)		-0.063*** (-0.106 to -0.021)			
Closeness centrality (standardized)			-0.053 (-0.124 to 0.018)		
Betweenness centrality (standardized)				-0.103*** (-0.155 to -0.051)	
Eigenvalue centrality (standardized)					-0.068*** (-0.103 to -0.033)
Age (years)	0.012 (-0.013 to 0.037)	0.011 (-0.014 to 0.035)	0.012 (-0.013 to 0.037)	0.011 (-0.014 to 0.035)	0.014 (-0.011 to 0.038)
Education					
No formal education	Base	Base	Base	Base	Base
Primary incomplete	-0.333** (-0.622 to -0.043)	-0.315** (-0.602 to -0.027)	-0.326** (-0.616 to -0.037)	-0.320** (-0.609 to -0.030)	-0.339** (-0.631 to -0.048)
Primary complete	-0.450*** (-0.777 to -0.124)	-0.437*** (-0.763 to -0.112)	-0.443*** (-0.771 to -0.115)	-0.447*** (-0.774 to -0.120)	-0.444*** (-0.773 to -0.115)
Secondary incomplete	-0.269* (-0.574 to 0.035)	-0.267* (-0.570 to 0.035)	-0.267* (-0.572 to 0.037)	-0.272* (-0.576 to 0.033)	-0.277* (-0.583 to 0.029)
Secondary complete or above	-0.114 (-0.452 to 0.223)	-0.105 (-0.441 to 0.230)	-0.114 (-0.452 to 0.223)	-0.125 (-0.462 to 0.211)	-0.131 (-0.470 to 0.208)
= 1 if born at Vashantek	-0.169** (-0.312 to -0.025)	-0.184** (-0.328 to -0.041)	-0.167** (-0.311 to -0.024)	-0.182** (-0.325 to -0.040)	-0.163** (-0.305 to -0.022)
= 1 if currently married	-0.190** (-0.367 to -0.013)	-0.198** (-0.375 to -0.022)	-0.188** (-0.364 to -0.011)	-0.179** (-0.353 to -0.004)	-0.171* (-0.346 to 0.004)
Equity Score (standardized)	-0.030 (-0.108 to 0.048)	-0.028 (-0.106 to 0.049)	-0.030 (-0.108 to 0.048)	-0.029 (-0.107 to 0.048)	-0.031 (-0.108 to 0.047)
Occupation Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	824	824	824	824	824
R-squared	0.036	0.047	0.036	0.043	0.038

Notes: The outcome variable is the standardized GHQ score in all five specifications. A higher GHQ score suggests worse mental health outcomes. The robust 95% CIs are reported in parentheses. We also control for occupations, which are not reported here. *** p<0.01, ** p<0.05, * p<0.1.

1 DISCUSSION

2 Our findings indicate the importance of social relations in determining mental well-being in
3 resource-constrained contexts. Social ties are important components of a much broader idea of
4 social capital, and observed outcomes can be associated with both the cognitive aspect of social
5 bonding and the constructivist dimension of local social institutions. [20] Hence, our results
6 further highlight the importance of the social determinants of health in the context of mental
7 health, a topic that has gained importance in both academic and policy literature in recent times.
8 [13,18,36]

9 Our results show that young men with better social ties and higher community embeddedness
10 and network report better mental health. We have used a number of different measures of social
11 network parameters at an individual level that are typical of a person's connectedness in his
12 immediate community. While this captures a particular aspect of a person's position in a broad
13 spectrum of social capital that he can accumulate over time, our estimates are robust and suggest
14 that connection with one's peer from his community is a strong predictor of his mental health
15 status.

16 Additionally, we should highlight the overall high average GHQ-12 score for our sample
17 from the general population. For example, in the context of Bangladesh, previous researchers
18 have found a GHQ-12 score of 20 with an SD of 3 among diagnosed mental patients. [27] While
19 clinical diagnoses of disorders require closer scrutiny and assessment by mental health
20 professionals, such high score suggests a potentially high psychosocial morbidity associated with
21 a high level of stress, anxiety, and possibly depression. Although we have focused on only one
22 neighborhood in Dhaka, the study area is not peculiar or remarkable in any observational way,
23 suggesting a broader implication and generalizability. In general, urban areas and youth

1 populations are prone to isolation and can suffer from psychological distresses and psychoses.
2 [36]

3 Social capital can influence one's psychological well-being in a number of ways, and our
4 study can only speculate the possible channels through which social ties can affect mental health
5 in our study population. [21] A social network can help individuals access material resources,
6 such as loans, grants, and health services. [12] We have found that the respondents in our sample
7 primarily rely on family members for their financial needs and community practitioners and
8 informal care providers such as salespersons in local pharmacies for health services. This result
9 suggests, within our context, that the social network promotes mental health primarily through
10 socioemotional supports and recreational activities. However, identifying the exact nature of
11 different channels requires further study and specific tools to measure different pathways through
12 which social ties can alter mental health outcomes.

13 Given the cross-sectional nature of our study, we cannot claim causality in our findings.
14 More specifically, it is possible that the association primarily picks up selection bias, where
15 people with certain psychosocial traits are self-selected into the social structure typified by
16 higher social ties and centrality, resulting in reverse causality that we cannot completely rule out
17 given the observational nature of the study. However, we include a set of socioeconomic factors
18 that are possible confounders of the mental health outcomes in our empirical models and we
19 block these influences by controlling them in all our empirical models. [37]

20 Also, using GHQ-12 to measure mental health outcomes limits our study, as this
21 questionnaire is not a clinical tool and captures a unidimensional unspecified psychological
22 morbidity. [29] Hence, this scale measures only the respondents' actual mental health status with
23 some measurement errors. This limits the total variation that we are able to explain using our

1 empirical models. We also capture important social ties, namely, friends in the community and
2 age-group. The respondents can have social ties and a network outside the community as well as
3 through social media. Such measurement errors lead to downward bias and smaller coefficients
4 (in absolute terms), as one can see in all our models. So our estimates can be considered lower
5 bounds for the true effects of social ties on the mental well-being of the respondents.

6 Despite these limitations, the findings presented here enhance our understanding of the social
7 network determinants of mental health in an exciting population. The postadolescent young
8 population is particularly important because, Bangladesh, like many low-middle-income
9 countries in the world, remains and will remain largely young for another generation or so. High
10 youth unemployment and underemployment rates can put a strain on men owing to traditional
11 gender expectations. [38] In this context, isolation and social disconnectedness can contribute to
12 poorer mental health, luring male youth to violence, which has become a concern locally in
13 recent times. Thus, our findings have important implications in understanding mental health
14 outcomes and policies that address psychosocial health issues of young men and highlight the
15 importance of social connection and ties in determining mental health in the post-adolescent
16 population in developing countries.

17 **Contributorship**

18 AR1 and MS conceived this study. AR led the analysis with guidance from NRB, AR2, and
19 MS. NRB led the collection and analyses of social network data with guidance from AR1. AR2
20 managed the overall data collection and preliminary analyses with guidance from AR1 and MS.
21 AR1 wrote the first draft and the final manuscript with contribution from MS. All authors have
22 seen and approved the final version of the manuscript.

23 **Conflicts of Interests**

1 All authors declare no conflicts of interest.

2 **Role of Funding Source**

3 The study was funded by WOTRO Science for Global Development of the Netherlands
4 Organization for Scientific Research (NWO) under grant number W 08,560.007. The funding
5 source did not play any role in designing the study or collecting, analyzing, or interpreting the
6 data or preparing this manuscript and deciding to submit the paper for publication.

7 **Data Sharing**

8 Extra data can be accessed via the Dryad data repository at <http://datadryad.org/> with the doi:
9 10.5061/dryad.320bv7b

10 **Ethical Approval**

11 The Institutional Review Board at the BRAC School of Public Health at BRAC University
12 reviewed and approved both the proposal and the data collection protocols. All the participants
13 provided written informed consent prior to the survey. The data collectors explained first the
14 research objective and the confidentiality that would be maintained after the gathering of
15 information from young men. Moreover, the entirely voluntary nature of participation in the
16 survey was carefully explained, and the participants could withdraw their participation at any
17 point of the survey, even after they signed the consent form. One copy of the written consent
18 form was given to the participant, and another copy was retained for official records.

19 **BIBLIOGRAPHY**

1 WHO. Mental disorders. [Internet]. 2017 [cited 2017 September 29]. Available from:

<http://www.who.int/mediacentre/factsheets/fs396/en/>.

- 2 Murray, et al. Global, regional, and national disability-adjusted life years (DALYs) for 306
diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990–2013:
quantifying the epidemiological transition. *The Lancet*. 2015;386(10009):2145 - 2191.
- 3 Vigo D, Thornicroft G, Atun R. Estimating the true global burden of mental illness. *The
Lancet Psychiatry*. 2016;3(2):171-178.
- 4 Steel Z, Marnane C, Iranpour C, Chey T, Jackson JW, Patel V, Silove D. The global
prevalence of common mental disorders: a systematic review and meta-analysis 1980–2013.
International journal of epidemiology. 2014;43:476-493.
- 5 Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, Charlson FJ,
Norman RE, Flaxman AD, Johns N, et al. Global burden of disease attributable to mental
and substance use disorders: findings from the Global Burden of Disease Study 2010. *The
Lancet*. 2013;382(9904):1575-1586.
- 6 Ferlander S. The importance of different forms of social capital for health. *Acta
Sociologica*. 2007;50(2):115-128.
- 7 Lund C, Breen A, Flisher AJ, Kakuma R, Corrigall J, Joska JA, Swartz L, Patel V. Poverty
and common mental disorders in low and middle income countries: a systematic review.
Social science & medicine. 2010;71(3):517-528.
- 8 Andrade LH, Wang YP, Andreoni S, Silveira CM, Alexandrino-Silva C, Siu ER, Nishimura
R, Anthony JC, Gattaz WF, Kessler RC, et al. Mental disorders in megacities: findings from

- 1
2
3 the Sao Paulo megacity mental health survey, Brazil. PloS one. 2012;7(2):e31879.
4
5
6
7 9 Gronholm PC, Thornicroft G, Laurens KR, Evans-Lacko S. Mental health-related stigma
8
9 and pathways to care for people at risk of psychotic disorders or experiencing first-episode
10
11 psychosis: a systematic review. Psychological Medicine. 2017;47:1867–1879.
12
13
14 10 Baum FE, Ziersch AM. Social capital. Journal of Epidemiology & Community Health.
15
16 2003;57(5):320-323.
17
18
19 11 Webber M, Huxley P, Harris T. Social capital and the course of depression: six-month
20
21 prospective cohort study. Journal of affective disorders. 2011;129(1):149-157.
22
23
24 12 Fafchamps M, Lund S. Risk-sharing networks in rural Philippines. Journal of Development
25
26 Economics. 2003;71(2):261-287.
27
28
29
30 13 WHO. Review of Social Determinants and the Health Divide in the WHO European
31
32 Region: Final Report. Copenhagen: World Health Organization; 2008.
33
34
35 14 Graney MJ. Happiness and Social Participation in Aging. Journal of Gerontology. 1975
36
37 701-706.
38
39
40
41 15 Diener E, Seligman M. Very Happy People. Psychological Science. 2002.
42
43
44 16 Holder MD, Coleman B. The Contribution of Social Relationships to Children’s Happiness.
45
46 Journal of Happiness Studies. 2009 329-349.
47
48
49 17 Cobb S. Social support as a moderator of life stress. Psychosomatic medicine.
50
51 1976;38(5):300-314.
52
53
54
55
56
57
58
59
60

- 1
2
3 18 De Silva MJ, McKenzie K, Harpham T, Huttly SRA. Social capital and mental illness: a
4 systematic review. *Journal of epidemiology and community health*. 2005;59(8):619-627.
5
6
7
8
9 19 Fowler JH, Christakis NA. Dynamic spread of happiness in a large social network:
10 longitudinal analysis over 20 years in the Framingham Heart Study. *BMJ*. 2008;337:a2338.
11
12
13
14 20 Bassett E, Moore S. Social capital and depressive symptoms: the association of
15 psychosocial and network dimensions of social capital with depressive symptoms in
16 Montreal, Canada. *Social Science & Medicine*. 2013;86:96-102.
17
18
19
20
21 21 Berkman LF, Glass T, Brissette I, Seeman TE. From social integration to health: Durkheim
22 in the new millennium. *Social science & medicine*. 2000;51(6):843-857.
23
24
25
26
27 22 Fujiwara T, Kawachi I. A prospective study of individual-level social capital and major
28 depression in the United States. *Journal of Epidemiology and Community Health*.
29 2008;62(7):627-633.
30
31
32
33
34 23 Rosenquist JN, Fowler JH, Christakis NA. Social network determinants of depression.
35 *Molecular psychiatry*. 2011;16(3):273-281.
36
37
38
39
40 24 Gayen K, Raeside R. Social networks, normative influence and health delivery in rural
41 Bangladesh. *Social science & medicine*. 2007;65(5):900-914.
42
43
44
45 25 Horng L, Dutta NC, Ahmed S, Rabbani A, Luby S, Uddin MJ. Peer Networking to Improve
46 Knowledge of Child Health and Immunization Services Among Recently Relocated
47 Mothers in Slums of Dhaka, Bangladesh. *Open Forum Infectious Diseases*. 2016;3(S1):625.
48
49
50
51
52
53 26 Perkins JM, Subramanian SV, Christakis NA. Social networks and health: a systematic
54
55
56
57
58
59

- 1
2
3 review of sociocentric network studies in low-and middle-income countries. *Social Science*
4 & *Medicine*. 2015;125:60-78.
5
6
7
8
9 27 Islam MN, Iqbal KF. Mental Health and Social Support. *The Chittagong Univ. J. B. Sci.*
10 2008;3(1&2):95-107.
11
12
13
14 28 Hossain MM, Siddique NEA, Habib MFB. Status of Marital Adjustment, Life Satisfaction
15 and Mental Health of Tribal (Santal) and Non-Tribal Peoples in Bangladesh: A
16 Comparative Study. *IOSR Journal Of Humanities And Social Science (IOSR-JHSS)*.
17 2017;22(4):5-12.
18
19
20
21
22
23
24 29 Hankins M. The reliability of the twelve-item general health questionnaire (GHQ-12) under
25 realistic assumptions. *BMC public health*. 2008;8(1):355.
26
27
28
29 30 Marsden PV. Recent developments in network measurement. In: Carrington PJ, Scott J,
30 Wasserman S. *Models and methods in social network analysis*. Cambridge University Press;
31 2005. p. 8-30.
32
33
34
35
36
37 31 Bonacich P. Power and Centrality: A Family of Measures. *American Journal of Sociology*.
38 1987 1170-1182.
39
40
41
42 32 Jackson MO. *Social and economic networks*. Princeton university press; 2010.
43
44
45 33 Chakraborty NM, Fry K, Behl R, Longfield K. Simplified asset indices to measure wealth
46 and equity in health programs: a reliability and validity analysis using survey data from 16
47 countries. *Global Health: Science and Practice*. 2016;4(1):141-154.
48
49
50
51
52
53 34 Wooldridge JM. *Econometric analysis of cross section and panel data*. Cambridge (MA):
54
55
56
57
58
59
60

1
2
3 The MIT Press; 2002.
4
5

6 35 BBS. Household Income and Expenditure Survey, 2010. Dhaka, Bangladesh: Bangladesh
7 Bureau of Statistics; 2011.
8
9

10
11 36 Krabbendam L, Os JV. Schizophrenia and urbanicity: a major environmental influence—
12 conditional on genetic risk. Schizophrenia bulletin. 2005;31(4):795-799.
13
14

15
16
17 37 Pearl J. Causality. Cambridge university press; 2009.
18
19

20 38 Economist Intelligence Unit. High university enrolment, low graduate employment
21 Analysing the paradox in Afghanistan, Bangladesh, India, Nepal, Pakistan and Sri Lanka.
22 [Internet]. 2014 [cited 2015 Jun 12]. Available from: <http://goo.gl/sVKaD9>.
23
24
25
26
27

28 1
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 1: Distribution of GHQ-12 scores

Notes. Based on 824 respondents. Here we report the non-standardized GHQ scores. The mean is shown as the vertical red line, and the median is shown as the vertical blue line. GHQ is the aggregate of 12 questions with possible values of 0, 1, 2 and 3. The scores of all 12 questions are added to measure the composite score for a respondent.

For peer review only

1
2
3 **1 Figure 2: Visualization of the friendship network of the 824 young men of Vashantek**
4

5
6 **2** Notes: Here we show the socio network graph for 824 respondents. Each node represents an individual respondent.
7
8 **3** The connector shows the friendship ties between two respondents. There are 267 respondents who are completely
9
10 **4** isolated (not included in the figure). The largest component consists of 450 respondents who are all connected with
11
12 **5** each other through intermediate ties. We also have 37 smaller components with smaller networks.
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

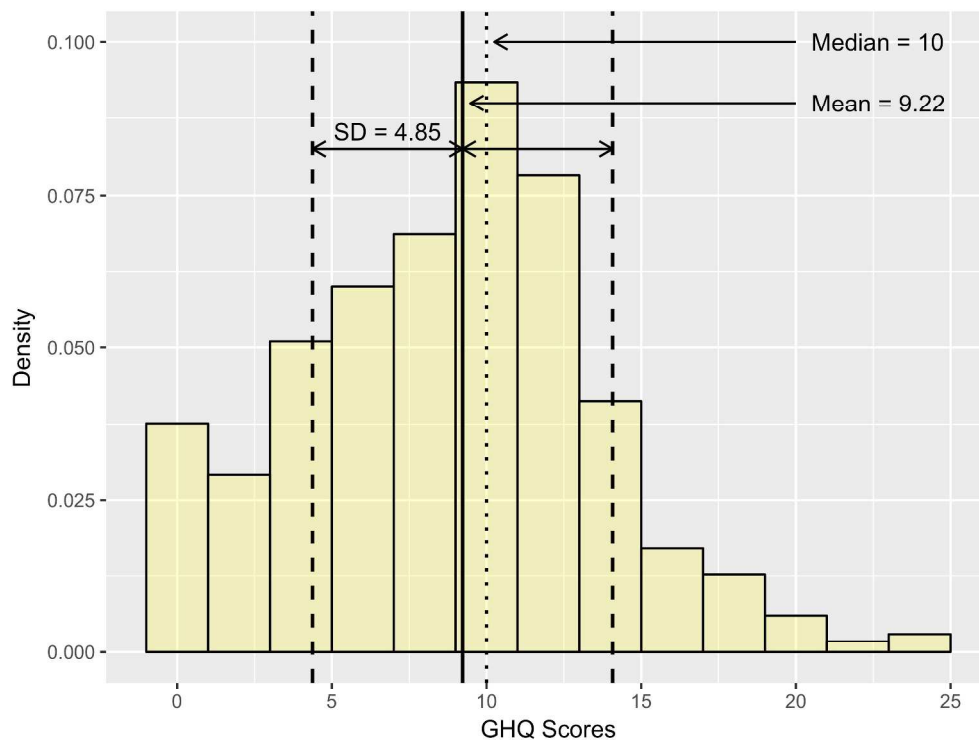


Figure 1: Distribution of GHQ-12 scores

325x243mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

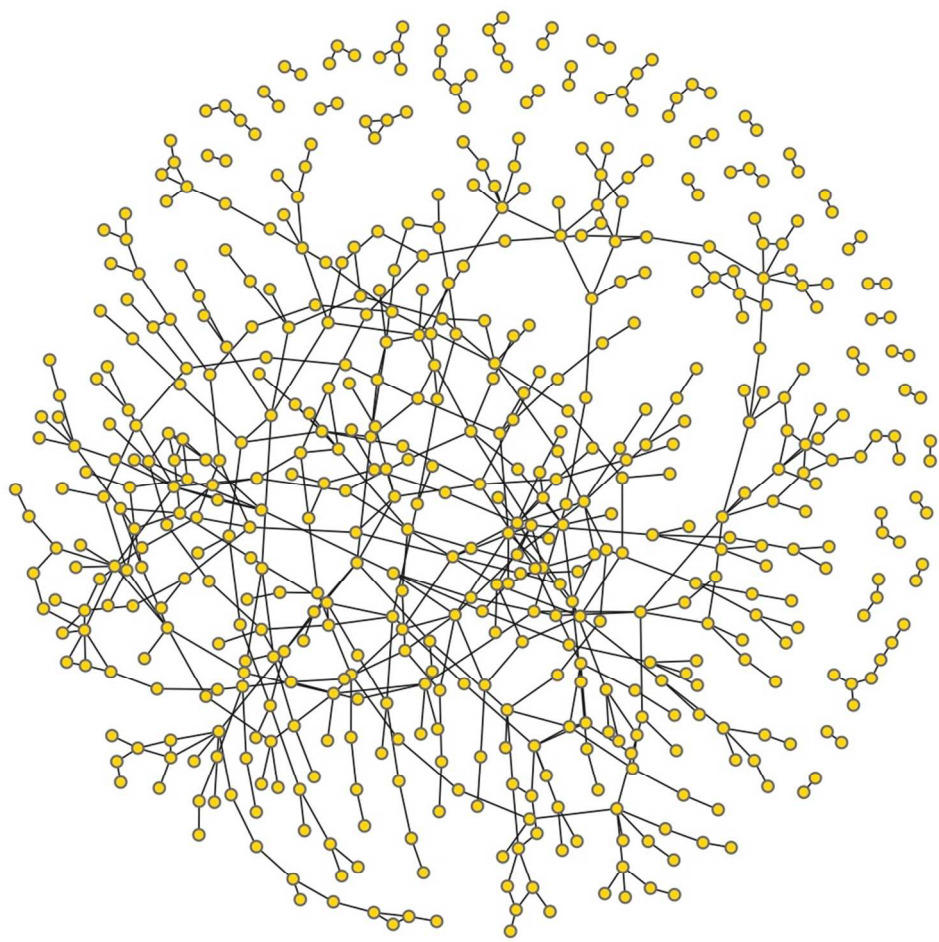


Figure 2: Visualization of the friendship network of the 824 young men of Vashantek

1 **A social network analysis of psychological morbidity in an urban slum of Bangladesh: a**
 2 **cross-sectional study based on a community census**

3 **APPENDIX A: DETAILED ITEM ANALYSES OF GHQ-12**

4 Here we present the detailed item-wise report from the Generalized Health Questionnaire we
 5 have implemented among our respondents (see Appendix Table 1). We have used a version of
 6 the GHQ-12 that has been previously translated and adopted in Bangladeshi context (Hossain,
 7 Siddique and Habib 2017, Islam and Iqbal 2008).

8 **Appendix Table 1: GHQ-12 Responses by Each Item**

	Reponses (fraction of total)				Mean	95% CI	
	Never	Sometimes	Often	Always			
	0	1	2	3			
Have you recently been able to; concentrate on what you are doing?	0.347	0.489	0.157	0.007	0.824	0.776	0.872
Have you recently lost much sleep over worry?	0.417	0.485	0.085	0.012	0.692	0.646	0.738
Have you recently felt you were playing important part in things?	0.369	0.468	0.159	0.004	0.797	0.749	0.846
Have you recently felt capable of making decisions about things?	0.214	0.567	0.211	0.008	1.015	0.968	1.061
Have you recently felt consistently under strain?	0.280	0.511	0.184	0.024	0.953	0.901	1.004
Have you recently felt you couldn't overcome your difficulties?	0.227	0.552	0.205	0.016	1.010	0.962	1.058
Have you recently been able to enjoy your normal day to day activity?	0.291	0.522	0.180	0.007	0.903	0.855	0.951
Have you recently been able to face up to your problems?	0.209	0.542	0.242	0.007	1.047	1.000	1.095
Have you recently been unhappy and depressed?	0.471	0.453	0.069	0.007	0.613	0.569	0.657
Have you recently been losing confidence in yourself?	0.715	0.221	0.028	0.036	0.386	0.337	0.435
Have you recently been thinking of yourself as a worthless person?	0.733	0.237	0.017	0.013	0.311	0.271	0.350
Have you recently been feeling reasonably happy, all things considered?	0.451	0.437	0.097	0.015	0.675	0.626	0.723
Overall GHQ-12					9.225	8.893	9.556

9

1
2
3 1 There are two suggested methods of scoring for GHQ-12. We have used the ‘four point
4
5 2 response scale’ or Likert method, which should allow more variation in the scores (see Hankins
6
7 3 2008). GHQ-12 typically captures the unidimensional nature of unspecified psychological
8
9 4 morbidity and commonly used in survey based instruments to measure the mental wellbeing in
10
11 5 different populations.
12
13

14 15 6 **APPENDIX B: CENTRALITY MEASURES** 16 17

18 7 While intuitive, just focusing on the number of friendship ties can mask the deeper structure
19
20 8 of social power or popularity within a network. We focus on a number of more sophisticated
21
22 9 measures of centrality which gauge one’s position in the entire network by analyzing not just the
23
24 10 number of people they are connected to but also the type of people they are connected to and
25
26 11 reveals to what extent that person is central/peripheral in his social network by analyzing their
27
28 12 network positions (Freeman 1978). While ‘node degree’ shows the extent of connectedness,
29
30 13 centrality shows how well and centrally each node is connected and we focus on a number of
31
32 14 them.
33
34
35

36 37 15 *Degree Centrality* 38

39 16 Degree centrality is simply the number of degrees each person has. In-degree centrality is the
40
41 17 number of referrals each person gets, out-degree centrality is the number of referrals each person
42
43 18 gives and all-degree centrality is the number of total referrals (summing both the referrals he
44
45 19 gives and the ones he gets). Hence, degree centrality is just the number of friendship ties each
46
47 20 respondent has normalized by the possible total number of ties ($N - 1$).
48
49
50

51 21 *Closeness Centrality* 52

53 22 Closeness centrality is the inverse of the average distance within a network. It measures how
54
55 23 distant a node is from the rest of the nodes and how many times it has to be crossed by other
56
57
58
59
60

1 nodes to reach some other node using the shortest path. Applying this in the context of our
 2 friendship network, we can measure how many stages a person requires to get connected to
 3 another random person or node in the network.

$$\text{Closeness Centrality}_i = \frac{n - 1}{\sum_{j \neq i} l(i, j)}$$

4 where, $l(i, j)$ denotes the number of links node i needs to reach to node j using the shortest path.
 5 Input closeness centrality and output closeness centrality take into account of the direction of
 6 referral while all closeness centrality does not.

7 *Betweenness Centrality*

8 Betweenness centrality is a measure of centrality based on how well situated a person is in
 9 terms of the paths he lies on (see Freeman 1978, Jackson 2010). This takes into account the
 10 number of shortest links connecting each node to all other nodes that pass through a particular
 11 node.

12 Let $P_i(j, k)$ denote the number of shortest paths between any two nodes j and k that pass
 13 through node i and, let $P(j, k)$ represent the number of shortest paths between these two nodes .
 14 Then,

$$\text{Betweenness Centrality}_i = \sum_{k \neq j, k, j} \frac{P_i(k, j)/P(k, j)}{(n - 1)(n - 2)/2}$$

15 where, n is total number of nodes. So in short, betweenness centrality of a node is equal to the
 16 number of geodesics passed through that particular node divided by the number of all the
 17 geodesics of any two other nodes.

1 *Eigenvector Centrality*

2 Eigenvector centrality measures a person's centrality based on the centrality of his direct
3 connections. Letting $C^e(g)$ denote the eigenvector centrality associated with a network g , then
4 the centrality of a node is proportional to the sum of the centrality of its neighbors. So,
5 eigenvector centrality, $\tau C_j^e(g) = \sum_i g_{ij} C_i^e(g)$. And in terms of matrix, $\tau C^e(g) = g C^e(g)$ where
6 $C^e(g)$ is an eigenvector of g and τ is the corresponding eigenvalue.

7 Eigenvector centrality is a better measure of social prestige as it takes account of the position
8 of the direct friends of each person (Bonacich, 2007). As a result, a person having very few but
9 centrally positioned friends will not be under-estimated to a person having a lot of almost
10 isolated or peripherally positioned friends. Eigenvector centrality is closely related to Bonacich
11 centrality and is a variant of Bonacich centrality. They are also used as a proxy for each other
12 (Bonacich, 1987, Bonacich, 1991).

13 **APPENDIX C: ROBUSTNESS CHECKS**

14 To test the validity of our statistical findings, we carry out some additional robustness checks
15 to see whether our estimates are sensitive to the models we have determined. The results are
16 presented in Appendix Table 2. We first restrict our models by dropping the 267 isolated
17 respondents. It is possible that our centrality measures can pick up the outcome differences
18 between these two groups. However, results in row (1) of Appendix Table 2 suggest this is not
19 the case. The estimate on the sub-sample is -0.098 (95% CI -0.151 to -0.044), which is very
20 similar to the value we found in column (4) in Table 3. The estimated coefficient on betweenness
21 centrality is not sensitive to excluding the isolated nodes. We also find that betweenness
22 centrality has too many zeros, hence, we define a dummy for respondents with non zero values
23 and re-estimate the model. We find negative association between mental health outcomes of the

1 respondents and those with non-zero betweenness centrality (-0.163, 95% CI -0.321 to -0.004,
 2 see row [2]). The results are very similar for eigenvector centrality as well (see rows [3] and [4]
 3 in Appendix Table 1). We also use a new measure of being influential within a network namely
 4 input proximity prestige index. We find that one SD higher value in this index is associated with
 5 0.06 SD lower GHQ score (95% CI -0.124 to 0.010, see row [5]), suggesting better mental health
 6 outcomes.

7 **Appendix Table 2: Robustness Checks**

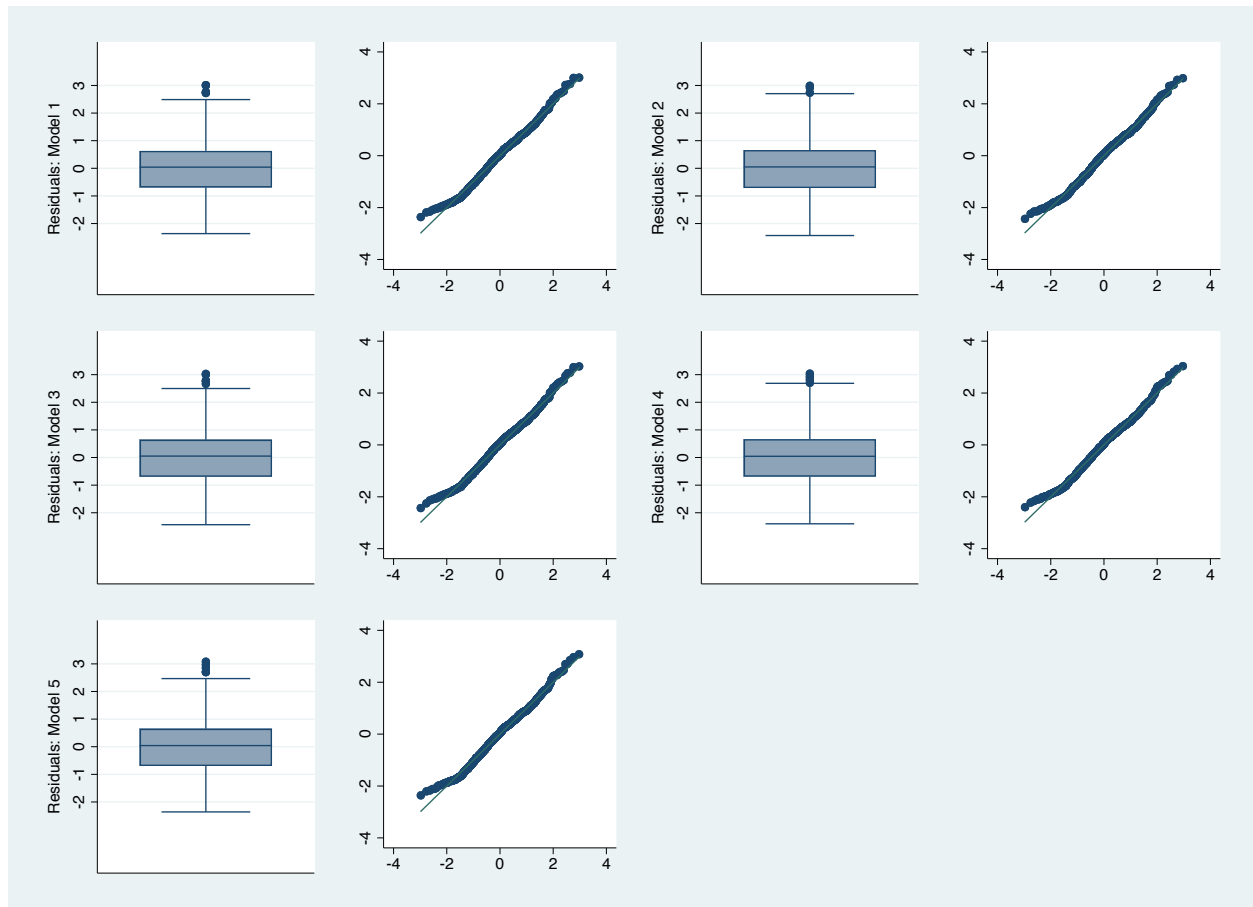
		Coefficient	(95% CI)	N	R ²
(1)	Betweenness Centrality (standardized) excluding isolated respondents	-0.098***	(-0.151 to -0.044)	557	0.058
(2)	= 1 if Betweenness Centrality > 0	-0.163**	(-0.321 to -0.004)	824	0.038
(3)	Eigenvector Centrality (standardized) excluding isolated respondents	-0.060***	(-0.098 to -0.023)	557	0.051
(4)	= 1 if Eigenvector Centrality > 0	-0.117	(-0.257 to 0.023)	824	0.037
(5)	Input Proximity Prestige (standardized)	-0.057*	(-0.124 to 0.010)	824	0.036
Results from ordered probit models					
(6)	All closeness centrality (standardized)	-0.052	(-0.124 to 0.019)	824	
(7)	Betweenness centrality (standardized)	-0.106***	(-0.177 to -0.034)	824	
(8)	Eigenvalue centrality (standardized)	-0.064*	(-0.133 to 0.006)	824	

8 Note: The outcome variable is the standardized GHQ score in all specifications. In specifications (1) and (3), we
 9 drop the respondents who do not have any friendship tie. In specifications (2) and (4), we use an indicator variable
 10 for respondents with non-zero centrality values. In specifications (6-8), we use ordered probit models for the discrete
 11 standardized GHQ score as the outcome variables. In all specifications, we have retained the control variables that
 12 we include in Table 3. The robust p-values are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

13 As we noted earlier, GHQ scores are essentially discrete in nature and we could actually
 14 reject null hypothesis of normality distribution in GHQ scores. So we have re-estimated the
 15 models with three centrality scores using ordered probit models and relaxed the normality
 16 assumption in the outcome variables. The results are presented in rows (6-8). We find that both

1 the point estimates and also the second moments are generally not sensitive to the alternative
 2 regression models.

3 Appendix Figure 1: Testing for Outliers in Residuals and QQ Plots



4 Note: In each panel, on the left we plot the box-plot for the residuals from each model reported in Table 3.
 5 On the right, we show the QQ plots for the same residuals.

6 APPENDIX D: DIAGNOSTIC TESTS FOR REGRESSION RESULTS IN TABLE 3

7 We present some diagnostic tests for the basic Gauss-Markov assumptions here (see
 8 Wooldridge 2002). Our outcome variable is discrete in nature so it is important test for
 9 normality. We also check for outliers in our models. We box plot the residuals for all five models
 10 from Table 3 and also plot the QQ chart to visually inspect the distributions for the residuals
 11 from the same models. We present the charts in different panels in Appendix Figure 1.

1 Simple visual inspections suggest there are few outliers in the residuals from all five models;
 2 however, the frequency does not warrant much concern. We also look at the quintile normal
 3 figures and residuals generally lie on the lines. While they may suggest that misspecifications
 4 may not be an issue we further use statistical tests to check the normality of the residuals. We
 5 show the results in Appendix Table 2.

6 **Appendix Table 2: Normality Tests**

Model	p-value	
	Shapiro-Wilk	Shapiro –Francia
1	0.00041	0.00121
2	0.00077	0.00213
3	0.00059	0.00163
4	0.00062	0.00172
5	0.00042	0.00119

7 Note. We report the p-values from Shapiro-Wilk and Shapiro-Francia tests
 8 for residuals from each model reported in Table 3.

9 The normality tests reported in Appendix Table 2 suggest that in all five models null of
 10 hypotheses of normality are rejected. Hence, we carry out further robustness checks with
 11 alternate specifications as reported in Appendix D below.

12 BIBLIOGRAPHY

13 Bonacich, Phillip. "Power and Centrality: A Family of Measures." *American Journal of*
 14 *Sociology*, 1987: 1170-1182.

15 Bonacich, Phillip. "Simultaneous group and individual centralities." *Social networks* 13, no.
 16 2 (1991): 155-168.

17 Bonacich, Phillip. "Some unique properties of eigenvector centrality." *Social networks* 29,
 18 no. 4 (2007): 555-564.

1
2
3 1 Freeman, Linton C. "Centrality in social networks conceptual clarification." *Social Networks*
4
5 2 1, no. 3 (1978): 215-239.
6
7

8 3 Hossain, Md. Mobarak, Nur-E-Alam Siddique, and Murshida Ferdous Binte Habib. "Status
9
10 4 of Marital Adjustment, Life Satisfaction and Mental Health of Tribal (Santal) and Non-Tribal
11
12 5 Peoples in Bangladesh: A Comparative Study." *IOSR Journal Of Humanities And Social Science*
13
14 6 (*IOSR-JHSS*) 22, no. 4 (2017): 5-12.
15
16
17

18 7 Islam, Md. Nurul, and Kazi Ferdous Iqbal. "Mental Health and Social Support." *The*
19
20 8 *Chittagong Univ. J. B. Sci* 3, no. 1&2 (2008): 95-107.
21
22

23 9 Wooldridge, Jeffrey M. *Econometric analysis of cross section and panel data*. Cambridge,
24
25 10 MA: The MIT Press, 2002.
26
27

28 11
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	N/A
		(c) Explain how missing data were addressed	N/A
		(d) If applicable, describe analytical methods taking account of sampling strategy	8
		(e) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-11
		(b) Indicate number of participants with missing data for each variable of interest	N/A

Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-13
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	See Appendix
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.