Determinants of health-related quality of life among adolescents with cerebral palsy in Bangladesh

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Abstract

Background: The health-related quality of life (HRQoL) of adolescents with cerebral palsy (CP) in low and middle-income countries is often poor, as is the case in Bangladesh. This study examined what modifiable factors are predictors of HRQoL among adolescents with CP in rural Bangladesh, a typical low- and middle-income country (LMIC). Methods: Adolescents with CP (10 to 18y) were identified using the Bangladesh Cerebral Palsy Register. HRQoL was assessed with the Cerebral Palsy Quality of Life-Teens questionnaire (CPQoL-Teens). Bivariate analysis and hierarchical multiple linear regression models related adolescent clinical characteristics and mental health, caregiver mental health and proxies of socioeconomic status to HRQoL outcomes. Results: 154 adolescents with CP (mean age 15y 1mo SD 1y 8mo, female n =31.2%) participated in this study. Numerous characteristics correlated to HRQoL; strongest correlation was between ‘feelings about functioning’ and motor impairment ( r =0.545). Nine factors were predictive of CPQoL-Teens dimensions; adolescent sex, school attendance, severity of motor impairment, hearing and speech impairment, mother’s education, primary caregiver depression and stress, and having a sanitary latrine at home resulting in score changes of between 0.79 (95% CI 0.24 to 1.35) to 35.1 (95% CI 6.03 to 64.22). Conclusions: Many of the factors predicting the HRQoL of adolescents with CP are amenable to intervention, and have the potential to improve adolescent wellbeing. Several determinants are priorities of the sustainable development goals (SDGs); these findings should inform resource prioritization to improve the wellbeing of adolescents with CP in Bangladesh and other LMICs.

Background

Health-related quality of life (HRQoL), a subjective multidimensional concept for measuring the interaction between health status and physical, psychological, and social aspects of wellbeing, is an emerging focus in low and middle-income countries (LMICs) such as Bangladesh (1). Particularly relevant to adolescents with cerebral palsy (CP), understanding of HRQoL can be used as an indicator of intervention outcomes and provide understanding of burden of disease (2). Moreover, understanding of HRQoL in LMICs flips the switch on poverty, allowing for focus on what people have, rather than what they do not (3).
CP is the major cause of childhood physical disability worldwide although the majority of cases are in LMICs (4). Estimated prevalence of CP in Bangladesh is 3.4 per 1,000 children and is likely to be associated with more severe physical, cognitive and communication impairments (5). Recent studies have determined that adolescents with CP in Bangladesh (6), and from other LMICs (7) have significantly poorer HRQoL outcomes than peers without disability, although little is known about determinants of HRQoL in these settings.

To date, the majority of HRQoL research has been conducted in high-income countries (HICs) and findings suggest it is predicted by a range of personal and environmental factors (8). For example, a European study of 551 adolescents with CP found psychological problems and parenting stress predicted HRQoL whereas socio-demographic and impairment severity characteristics did not (9). Other studies set in HICs have reported that impairment, in particular motor functioning, is predictive of physical wellbeing dimensions of HRQoL (10, 11). These are important findings to inform HRQoL research in LMIC settings, however patterns of HRQoL appear to be different between HIC and LMIC (7, 8). It is therefore reasonable to suggest that determinants of HRQoL will also differ between HIC and LMIC, requiring specific exploration.

Only a handful of studies from LMICs have examined determinants of HRQoL among children and adolescents with CP, of which only one has examined predictive relationships (7). The Turkish study of 40 children with CP found that, among other factors, motor function was predictive of ‘physical wellbeing’ using the Paediatric Quality of Life Inventory (12); other studies have confirmed an association between motor function and HRQoL (12–16). Studies from LMICs have also indicated a relationship between HRQoL dimensions and factors such as child age (13), child sex (13), child education (17), family income (13), speech impairment (18), cognitive impairment (14, 18), visual impairment (14), epilepsy/seizure disorder (14, 15, 18), caregiver age (16), and mother’s education (13). However, due to the emerging nature of HRQoL research in LMICs many of these findings require further exploration and replication. Currently, to the best of our knowledge there is no research on determinants of HRQoL of adolescents with CP from Bangladesh.

The present study examines what modifiable factors predict caregiver-reported HRQoL of adolescents
with CP in rural Bangladesh. We have included factors either informed by previous research or considered relevant to the research context including priority areas of the sustainable development goals of which Bangladesh is an adoptee (19). Moreover, mental health is a significant issue among caregivers of adolescents with CP in rural Bangladesh (20) and is included as a potential determinant in our analysis. We also explore proxies of socio-economic status related to housing infrastructure due to their potential impact on adolescent wellbeing in the study context.

Methods
Study design, setting and participants
This study is part of the Bangladesh CP Health-related Quality of life (Bangladesh CPQoL) research project. Participants were considered eligible for this study if aged between 10 and 18 years old, a normative classification of adolescence in Bangladesh (21), and were registered with the Bangladesh Cerebral Palsy Register (BCPR) \((n = 192\) at the time of the present study).

BCPR is the first ongoing surveillance program of children with CP in an LMIC. The population-based register covers a defined geographical region of the Shahjadpur sub-district of Sirajganj in the northern part of Bangladesh and holds data on socio-demographic, clinical (including severity, aetiology, associated impairments and risk factors), nutrition, education and rehabilitation status of children and adolescents with CP in Bangladesh.

Key Informant Methodology described in Khandaker, Smithers-Sheedy (22) is used to identify children and adolescents for BCPR.

Information about adolescents was proxy-reported by primary-caregivers (i.e. parent, grandparent, other relative or close adult friend who provided the majority of their care and support). Adolescents provided self-reported data as part of the broader Bangladesh CPQoL research project however this is not reported for the present study.

Informed verbal and written consent were obtained for all individual participants included in the study. In cases of illiteracy, written consent was obtained by thumbprint. For participants under 16 years, written consent was provided by a parent or guardian. This study adhered to STROBE guidelines and all methods described adhered to the ethical approvals provided by the Bangladesh
Medical Research Council (BMRC/NREC/2013–2016/1165) and University of Sydney Human Research Ethics Committee (2016/646).

Measures

Demographic and impairment characteristics: Bangladesh Cerebral Palsy Register (BCPR)

We extracted demographic and clinical information about adolescents from the BCPR database including age, sex, type of CP, severity of motor impairment using the gross motor function classification system (GMFCS), other associated impairments, school attendance and proxies of socio-economic status such as monthly family income, household crowding, access to running water and sanitation. Impairments were categorized as yes/no based on existing diagnosis or presence of impairment during BCPR assessment. GMFCS is a five level classification system; children classified at GMFCS level 1 are independently ambulant whereas children at Level V require wheeled mobility (23). BMI was calculated as weight divided by height and considered underweight if <18.5. Type of housing was defined as Kutcha (houses made from mud, thatch or other organic materials, considered impermanent); semi-pucca housing (made with a combination of materials, considered semi-permanent); and pucca (made from brick, stone, timber or cement, considered permanent). Number of household members was divided by number of rooms to provide persons per room rate of crowding. Non-sanitary latrine was defined as a latrine that discharges into open space.

Health-related quality of life: Cerebral Palsy Quality of Life—Teens (CPQoL-Teens)

Adolescent HRQoL was assessed using the Bengali version of Cerebral Palsy Quality of Life—Teens questionnaire (CPQoL-Teens) (24, 25). CPQoL-Teens is a condition specific instrument that uses a nine point Likert scale to assess 88 items across seven dimensions; ‘general wellbeing and participation’, ‘communication and physical health’, ‘school wellbeing’, ‘social wellbeing’, ‘feelings about functioning’, ‘access to services’ (proxy-report only) and ‘family health’ (proxy-report only). CPQoL-Teens scores for this sample are reported previously in Power, Muhit (6).

Adolescent mental health: Strengths and Difficulties
Questionnaire

Adolescent mental health was assessed using the Bengali version of Strengths and Difficulties questionnaire (SDQ) (26). SDQ is a brief behavioural screening tool that assesses ‘emotional symptoms’, ‘conduct problems’, ‘hyperactivity/ inattention’, ‘peer relationship problems’, and ‘pro-social behaviour’. Adolescent mental health scores for this sample are reported previously in Power, Muhit (6).

Caregiver mental health: Depression, Anxiety and Stress Scale - 21

Caregiver mental health was assessed using the Bengali version of ‘Depression, Anxiety and Stress Scale’ (DASS–21) (27). DASS–21 is a 21-item standardized self-report questionnaire designed to measure the negative related emotional states of ‘depression’, ‘anxiety’ and ‘stress’. Caregiver mental health scores for this sample are reported previously in Power, Muhit (20).

Statistical methods

Descriptive statistics were used to summarise the cohort. Data was assessed for normality using Shapiro Wilk and visual inspection of residual plots. Bivariate analysis using Spearman’s correlation was conducted to determine the relationship between HRQoL and adolescent and caregiver characteristics and proxies of socio-economic status; correlation were considered small (≤0.49), medium (0.50 to 0.79), and large (≥0.80) (28). Hierarchical multiple linear regression was used to determine predictors of HRQoL. Included predictor variables were selected on the basis of statistical (i.e. significant association to HRQoL, p<0.050) and theoretical concerns. Assumptions of linearity, homoscedasticity and normality were assessed through examination of residual plots; independence of observations assessed with Durbin-Watson statistic, and Multicollinearity assessed through correlation, tolerance and variance inflation factor (VIF) coefficients. No adjustment was made for multiple testing due to the investigative nature of the study. All statistical analysis was conducted using SPSS version 24 (IBM Armonk, NY, USA). A p value of <0.050 was considered significant.

Results

Participant characteristics

192 adolescents with CP aged 10 to 18 years were enrolled in BCPR at the time of the present study.
154 (mean age 15y 1mo) agreed to participate of which 48 (31.2%) were female. Participation rate was 80.2%.

Characteristics of adolescents with CP and caregivers are provided in Table 1. Majority of adolescents had spastic type CP, of which quadriplegia and monoplegia/hemiplegia were most common; required wheeled mobility (i.e. GMFCS level III and above); and were underweight. More than half had cognitive impairment and more than two thirds had speech impairment. Majority had never received any rehabilitation or attended school, lived in kutcha housing (impermanent) and had limited infrastructure in the home such as lack of running tap water; approximately one third had either a non-sanitary latrine or no toilet facility.

Relationships of HRQoL outcomes to characteristics

Bivariate analysis

Results of correlation analysis are shown in Table 2. Significant correlations were observed for all CPQoL-Teens sub-dimensions with small to moderate effect ($r = 0.164$ to $0.545$), with exception of ‘school wellbeing’ which did not report any significant correlations ($p>0.05$).

‘General wellbeing and participation’ significantly correlated to 8 characteristics; school attendance, GMFCS, cognitive impairment, speech impairment, mother education, family income, housing permanence and sanitation; ‘Communication and physical health’ to 5 characteristics; school attendance, GMFCS, cognitive impairment, speech impairment and caregiver depression; ‘Social wellbeing’ to 6 characteristics; school attendance, cognitive impairment, speech impairment, mother age, mother education and housing permanence; ‘Feelings about functioning’ to 5 characteristics; school attendance, GMFCS, cognitive impairment, speech impairment and sanitation; ‘Access to services’ to 4 characteristics; being male, caregiver depression, anxiety and stress; and ‘Family health’ to 10 characteristics; school attendance, GMFCS, hearing impairment, mental health, mother age, mother education, caregiver depression, anxiety and stress, family income.

Hierarchical multiple linear regression

Hierarchical multiple linear regression was conducted to determine predictors of CPQoL-Teens.

Assumptions of linearity, homoscedasticity and normality were met for all dimensions. Anxiety and
stress were removed from the model for ‘access to services’, depression and anxiety from ‘family health’ and sanitation from ‘general wellbeing and participation’ due to multicollinearity. Assumptions of multicollinearity were met when these items were removed, and for all other dimensions. The final models for each dimension, see Table 3, explained 14.3% to 24.4% of variation in scores. Nine variables independently predicted the CPQoL-Teens sub-dimensions; GMFCS Level 5, adolescent education and mother education predicted ‘general wellbeing and participation’. Adolescent education and caregiver depression predicted ‘communication and physical health’. Adolescent education, speech impairment and access to a toilet in the home were predictive of ‘feelings about functioning’. Adolescent sex and caregiver depression predicted ‘access to services’. Hearing impairment, adolescent education and caregiver stress predicted family health. No variables were found to be predictive of social wellbeing.

Discussion
This study examined what factors predict proxy-reported HRQoL of adolescents with CP in rural Bangladesh. We assessed adolescent impairment characteristics and mental health, caregiver mental health, and proxies of socio-economic status. Our findings identified numerous factors correlated to HRQoL of which nine were predictive. Majority of the identified factors are amenable to intervention and are priorities of the sustainable development goals such as ‘gender equality’, ‘quality education’ and ‘clean water and sanitation’.

Our study examined the relationship between HRQoL and adolescent sex. We found that sex was predictive of ‘access to services’ with a higher proportion of males reporting better outcomes in this dimension. This finding is unique, although caution is recommended in interpretation due to the high proportion of male participants in our sample. Other studies from LMICs have reported a non-significant relationship between HRQoL dimensions and participant sex (12, 15, 17, 29), with exception of a study of children with CP in India (14) which reported males to have poorer overall HRQoL. The apparent sex-bias in the present study may be understood by considering the broader socio-cultural context in Bangladesh. Prioritisation of males for health care and family resources is culturally prevalent, and is more marked for those living below the poverty line (30).
School attendance was a significant predictor of four CPQoL-Teens dimensions. Children with disability in Bangladesh have the right to attend school enshrined in legislation (31) however a range of issues often prevent participation, such as non-acceptance from the school, parent refusal and transport issues; moreover non-school attendance among adolescents with CP in rural Bangladesh is associated with severity of motor impairment, cognitive and/or speech impairment (6). Over half of adolescents with CP in our study had mild to moderate CP (59.7% with GMFCS I-III) however only 25.3% of participants attended school. Our findings of poorer wellbeing among non-school attenders supports that of a Brazilian study into children with CP (17).

We examined the relationship between adolescent impairments and HRQoL. Adolescent motor impairment (GMFCS L5), hearing and speech impairment were predictive of one CPQoL-Teens dimension each. Previous studies from LMICs have indicated a relationship between motor function and physical wellbeing dimensions of HRQoL, although no relationship has been consistently reported regarding other associated impairments (7). Whilst the impairments themselves may not typically be modifiable, address of social stigma in the case of hearing impairment (32), and provision of hearing aids or implementation of non-verbal communication methods (33) may assist to improve outcomes in these dimensions. Cognitive impairment was associated with reduced scores on numerous CPQoL-Teens dimensions, however this was not predictive.

Caregiver characteristics correlated to, or were predictive of CPQoL-Teens dimensions, notably mother’s age and education. Interestingly, the relationships of these factors were not significant for fathers. These findings have important implications for future intervention design; in Bangladesh mothers typically undertake the majority of caregiving and due to an absence of services and support they may hold the primary responsibility for their children’s rehabilitation/ physical therapy (34). Investing in mother’s education and provision of targeted interventions through mothers has the potential to increase understanding of effective mechanisms for improving the HRQoL of adolescent with CP. Moreover, the present study confirmed previous reports that caregiver mental health is an important predictor of adolescent HRQoL (9, 35) although effect in the present study was small.

We examined the relationship of several proxies of socio-economic status and HRQoL. Notably family
income, living in permanent housing and having a sanitary latrine correlated to, or were predictive of CPQoL-Teens dimensions. Personal hygiene is likely to be a challenge for adolescents with motor impairments in the absence of assistive devices. Over one third of adolescents lived in housing without a sanitary latrine, indicating a daily struggle, forcing dependence on caregivers for essential daily tasks, and potentially increasing vulnerability to neglect and abuse.

There are a number of strengths and limitations to the present study. To the best of our knowledge this is the first study using a population-based sample to examine predictors of HRQoL among adolescents with CP in an LMIC. Moreover, we examined numerous variables that are likely to have a unique effect on HRQoL in LMICs. Our sample was homogenous in terms of socio-economic status, a possible limitation to our findings, and we examined determinants of proxy-reported HRQoL only. Due to the subjective nature of HRQoL, self-reported HRQoL data is ideal and has been reported elsewhere (6) however were not included in the present analysis. We recommend future replication of our study in other regions of Bangladesh may help to confirm our findings. Moreover, we recommend future research examine the effectiveness of interventions to improve adolescent HRQoL outcomes.

Conclusions
The health-related quality of life of adolescents with CP in rural Bangladesh is predicted by numerous factors, many of which are modifiable. Adolescent and maternal access to education, caregiver depression and stress, infrastructure in the home (sanitary latrines) were predictive of CPQoL-Teens dimensions and should be considered in intervention development and resource allocation due to their probable benefits to HRQoL. Moreover, consideration of socio-cultural factors in resource allocation such as sex-bias may be important to reduce gender-inequality. Specific interventions addressing wellbeing and participation of adolescents with severe motor impairment and address of stigma impacting adolescents with hearing and/or speech impairment may have the potential to improve adolescent wellbeing. Our findings should inform resource prioritization in order to improve the HRQoL of adolescents with CP in Bangladesh.

List Of Abbreviations
BCPR = Bangladesh cerebral palsy register
Declarations
Ethics approval and consent to participate
Informed verbal and written consent were obtained for all individual participants included in the study. In cases of illiteracy, written consent was obtained by thumbprint. For participants under 16 years, written consent was provided by a parent or guardian. This study adhered to STROBE guidelines and all methods described adhered to the ethical approvals provided by the Bangladesh Medical Research Council (BMRC/NREC/2013–2016/1165) and University of Sydney Human Research Ethics Committee (2016/646). All procedures performed in this study were in accordance with the ethical standards of these institutes and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication
Not applicable

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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decision to submit the paper for publication.

Author’s contribution
This study was conceived and designed by GK, MM, RP, EH, TK and GK, made substantial contributions to the acquisition of data. RP, CG, MM, EH, TK, NB and GK made substantial contribution to the analysis and interpretation of data. RP conducted the statistical analysis with input from CG. RP wrote the first draft and CG, MM, EH, TK, NB and GK critically reviewed the manuscript and provided important intellectual content. All authors approved the final manuscript for publication.

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Tables

Table 1. Participant socio-demographic and impairment characteristics

| Adolescent characteristics | |
|----------------------------|--------------------------|
| **Age** Mean (SD)          | 15y 1mo (1y 8mo)         |
| **Sex** (n,%)              |                          |
| Female                     | 48 (31.2%)               |
| Male                       | 106 (68.8%)              |
| **BMI** Median (IQR)       | 17.0 (4.7)               |
| **GMFCS** (n,%)            |                          |
| Level I                    | 36 (23.4%)               |
| Level II                   | 23 (14.9%)               |
| Level III                  | 33 (21.4%)               |
| Level IV                   | 20 (13.0%)               |
| Level V                    | 41 (26.6%)               |
| Unknown                    | 1 (0.6%)                 |
| **Type of CP** (n,%)       |                          |
Spastic
  *Monoplegia/hemiplegia* 41 (26.6%)
  *Diplegia* 27 (17.5%)
  *Triplegia* 12 (7.8%)
  *Quadriplegia* 43 (27.9%)
Hypotonia 3 (1.9%)
Dyskinesia 14 (9.1%)
Ataxia 1 (0.6%)
Unknown/ unclassified 13 (8.4%)

**Associated impairment (n,%)**
- Epilepsy 36 (23.4%)
- Cognitive impairment 87 (56.5%)
- Visual impairment 12 (7.8%)
- Hearing impairment 19 (12.3%)
- Speech impairment 103 (66.9%)

**Education**
- None 115 (74.7%)
- Primary, secondary or above 39 (25.3%)

**Rehabilitation (any type) (n,%)** 43 (27.9%)

| Caregiver characteristics |
|---------------------------|
| **Caregiver age** |
| Mean (SD) | 39y 9mo (9y 9mo) |
| **Caregiver sex (n,%)** |
| Female | 126 (81.8%) |
| Male | 28 (18.2%) |
| **Caregiver education (n,%)** |
| None | 86 (55.8%) |
| Primary, secondary and above | 68 (44.2%) |

| Proxies of SES |
|----------------|
| **Monthly family income (BDT)** |
| BDT Median (IQR) | 6000 (5000) |
| USD Median (IQR) | 60.94 (59.12) |
| **Housing permanence (n,%)** |
| Kutch house (impermanent) | 119 (77.3%) |
| Semi-pucca house (semi-permanent) | 20 (13.0%) |
| Pucca house (permanent) | 15 (9.7%) |
| **Household crowding** |
| Median people/ room (IQR) | 3.0 (1.7) |
| **Source of drinking water (n,%)** |
| Tube well | 149 (96.8%) |
| Tap water | 5 (3.2%) |
| **Sanitation (n,%)** |
| No toilet facility | 3 (1.9%) |
| Non-sanitary latrine | 50 (32.5%) |
| Sanitary latrine | 101 (65.6%) |

Table 2. Spearman’s rho correlation matrix of HRQoL to characteristics of adolescents with CP
## Adolescent characteristics

| Variable                                    | GWP   | CPH   | SWB   | SOC   | FF    | AS    |
|---------------------------------------------|-------|-------|-------|-------|-------|-------|
| Age                                         | -0.044| -0.016| -0.244| -0.115| 0.012 | 0.12  |
| Sex                                         | 0.138 | 0.152 | 0.081 | 0.005 | 0.055 | .227* |
| BMI                                         | -0.071| -0.020| -0.061| -0.071| 0.071 | 0.04  |
| Motor impairment (GMFCS)                    | -.274**| -.199*| -0.148| -0.111| -.545**| -0.04 |
| Epilepsy                                    | 0.122 | 0.151 | 0.297 | 0.118 | 0.154 | 0.15  |
| Cognitive impairment                        | .251**| .244**| 0.232 | .221**| .180* | 0.08  |
| Visual impairment                           | -0.012| -0.003| -0.295| 0.018 | -0.012| -0.01 |
| Hearing impairment                          | -0.028| 0.002 | 0.195 | 0.054 | -0.001| -0.02 |
| Speech impairment                           | .280**| .302**| 0.170 | .211**| .330**| -0.03 |
| Education                                   | .379**| .328**| -0.028| .274**| .330**| -0.09 |
| Service Access                              | 0.044 | 0.015 | -0.243| -0.011| 0.102 | -0.02 |
| Mental health (SDQ)                         | -0.120| -0.124| 0.092 | -0.124| 0.016 | 0.12  |

## Caregiver characteristics

| Variable                                    | GWP   | CPH   | SWB   | SOC   | FF    | AS    |
|---------------------------------------------|-------|-------|-------|-------|-------|-------|
| Mother age                                  | -0.14 | -0.089| 0.162 | -0.168*| -0.035| 0.03  |
| Father age                                  | -0.152| -0.09 | 0.228 | -0.082| -0.072| -0.01 |
| Mother education                            | .209**| 0.158 | 0.093 | .223**| 0.076 | 0.06  |
| Father education                            | 0.113 | 0.052 | 0.04  | 0.144 | -0.016| 0.05  |
| Depression                                  | 0.143 | .168* | 0.273 | -0.045| 0.148 | .349* |
| Anxiety                                     | 0.124 | 0.107 | 0.148 | -0.049| 0.087 | .252* |
| Stress                                      | 0.008 | 0.014 | 0.099 | -0.108| 0.008 | .234* |

## Proxies of SES

| Variable                                    | GWP   | CPH   | SWB   | SOC   | FF    | AS    |
|---------------------------------------------|-------|-------|-------|-------|-------|-------|
| Family income (monthly)                     | .165* | 0.093 | -0.096| 0.123 | 0.032 | 0.06  |
| Housing permanence                         | .173* | 0.115 | 0.115 | .185* | 0.074 | 0.02  |
| Household crowding                         | 0.005 | -0.019| 0.006 | 0.013 | -0.113| 0.02  |
| Source of drinking water                   | 0.038 | 0.068 | 0.181 | 0.144 | -0.019| -0.05 |
| Sanitation                                 | .164* | 0.069 | -0.183| 0.144 | .207**| 0.08  |

### Variables:
- Sex: 0=Female, 1=Male; GMFCS: 1=Level I, 2=Level II, 3=Level III, 4=Level IV, 5=Level V; Epilepsy, Intellectual disability, Hearing, Speech, Visual impairment: 0=Yes, 1=No; Education: 0=None, 1=Primary or above; Service access: 0=Yes, 1=No; Housing permanence 1=Kutcha, 2=Semi-pucca, 3=Pucca; Source of drinking water 0=Tube well, 1=Tap water; Sanitation 1=No toilet, 2=Non-sanitary latrine, 3=Sanitary latrine.
- GWP = general wellbeing and participation; CPH = communication and physical health; SWB = school wellbeing; SOC = social wellbeing; FF = feelings about functioning; AS = access to services; FH = family health
- * p<0.050; ** p<0.010

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Table 3. Hierarchical multiple regression predicting CPQoL-Teens sub-dimensions

| Variable | Final Model: B (95% CI) |
|----------|-------------------------|
| **General wellbeing and participation** | | 
| GMFCS: LI | Reference |
| GMFCS: LII | 2.05 (-8.25 to 12.36) | -0 |
| GMFCS: LIII | -1.49 (-10.92 to 7.95) | -0 |
| GMFCS: LIV | -6.17 (-17.45 to 5.12) | -0 |
| **GMFCS: LV** | -10.36 (-19.92 to -0.80) | -0.2 |
| Cognitive impairment | 5.16 (-2.41 to 12.73) | -0 |
| Speech impairment | 1.23 (-7.17 to 9.63) | -0 |
| Adolescent education: None | Reference |
| **Adolescent education: Primary or above** | 9.51 (0.52 to 18.49) | 0.1 |
| Mother education: None | |
| **Mother education: Primary or above** | 9.05 (2.16 to 15.93) | 0.1 |
| Family income | 0.00 (0.00 to 0.00) | -0 |
| Housing permanence: Kutchha (impermanent) | Reference |
| Housing permanence: Semi-pucca (semi-permanent) | 5.68 (-4.12 to 15.47) | -0 |
| Housing permanence: Pucca (permanent) | 6.25 (-5.72 to 18.22) | -0 |

R² = 0.244 F = 4.138**

| **Communication and physical health** | | 
| GMFCS: LI | Reference |
| GMFCS: LII | 0.73 (-8.04 to 9.49) | -0 |
| GMFCS: LIII | 3.35 (-4.69 to 11.39) | -0 |
| GMFCS: LIV | 2.10 (-7.39 to 11.59) | -0 |
| GMFCS: LV | -3.58 (-11.70 to 4.54) | -0 |
| Cognitive impairment | 4.08 (-2.37 to 10.53) | -0 |
| Speech impairment | 3.31 (-3.83 to 10.44) | -0 |
| Adolescent education: None | Reference |
| **Adolescent education: Primary or above** | 8.24 (0.74 to 15.74) | 0.1 |
| **Caregiver depression** | 0.79 (0.24 to 1.35) | 0.2 |

R² = 0.204 F = 3.486**

| **Social wellbeing** | | 
| Cognitive impairment | 5.77 (-1.28 to 12.82) | -0 |
| Speech impairment | 2.48 (-5.45 to 10.41) | -0 |
| Education: None | Reference |
| Education: Primary or above | 5.89 (-2.29 to 14.08) | -0 |
| Mother age | -0.36 (-0.87 to 0.16) | -0 |
| Mother education: None | Reference |
| Mother education: Primary or above | 5.25 (-1.37 to 11.87) | -0 |
| Housing permanence: Kutchha (impermanent) | Reference |
| Housing permanence: Semi-pucca (semi-permanent) | 4.45 (-4.97 to 13.88) | -0 |
| Housing permanence: Pucca (permanent) | 5.16 (-5.12 to 15.43) | -0 |

R² = 0.143 F = 3.551**

| **Feelings about Functioning** | | 
| Adolescent education: None | Reference |
| **Adolescent education: Primary and above** | 12.2 (1.65 to 22.84) | 0.1 |
| Cognitive impairment | -1.5 (-10.89 to 7.94) | -0 |
| **Speech impairment** | 14.6 (4.10 to 25.08) | 0.2 |
| Sanitation: No toilet facility | Reference |
| Sanitation: Non-sanitary latrine | 25.3 (-4.34 to 54.93) | -0 |
| **Sanitation: Sanitary latrine** | 35.1 (6.03 to 64.22) | 0.4 |

R² = 0.200 F = 7.381**
### Access to Services

| Variable                  | Estimate (95% CI) | P-value |
|---------------------------|-------------------|---------|
| Sex: Female               | Reference          |         |
| Sex: Male                 | 10.63 (2.82 to 18.44) | 0.21    |
| Caregiver depression      | 1.95 (1.22 to 2.68)  | 0.21    |

**R² = 0.199 F = 18.729**

### Family Health

| Variable                                      | Estimate (95% CI) | P-value |
|-----------------------------------------------|-------------------|---------|
| Cognitive impairment                         | 3.44 (-4.14 to 11.02) | 0.48    |
| **Hearing impairment**                       | 11.33 (0.57 to 22.09) | 0.01    |
| Adolescent education: None                   | Reference          |         |
| Adolescent education: Primary or above       | 9.10 (0.53 to 17.66)  | 0.03    |
| Mental health                                | -0.30 (-1.01 to 0.42)  | 0.43    |
| Mother age                                   | -0.44 (-1.02 to 0.13)  | 0.28    |
| Mother education: None                       | Reference          |         |
| Mother education: Primary or above           | 2.30 (-5.24 to 9.85)   | 0.62    |
| **Caregiver stress**                         | -1.21 (-2.16 to -0.25) | -0.24   |
| Family income                                | 0.00 (0.00 to 0.00)   | 0.00    |

**R² = 0.215 F = 4.954**

* p<0.050; ** p<0.010