PLOS ONE

RESEARCH ARTICLE

Developmental delay and its associated factors among children under five years in urban slums of Nepal

Anupama Bishwokarma[1]*, Diwash Shrestha[2], Kshitiz Bhujel[3], Natasha Chand[4], Laxmi Adhikari[1], Maheshor Kaphle[1], Ayurma Wagle[1], Isha Karmacharya[1]

1 Department of Public Health, CiST College, Pokhara University, Kathmandu, Nepal, **2** Department of Computer Science and Information Technology, Asian College of Higher Studies, Tribhuvan University, Kathmandu, Nepal, **3** Neuro Surgery Department, Annapurna Neurological Institute & Allied Sciences, Kathmandu, Nepal, **4** Integrated Health Information Management Section, Department of Health Services Nepal, Kathmandu, Nepal

* bishwokarma.anupama@gmail.com

Citation: Bishwokarma A, Shrestha D, Bhujel K, Chand N, Adhikari L, Kaphle M, et al. (2022) Developmental delay and its associated factors among children under five years in urban slums of Nepal. PLoS ONE 17(2): e0263105. https://doi.org/10.1371/journal.pone.0263105

Editor: Srinivas Goli, University of Western Australia, AUSTRALIA

Received: February 18, 2021

Accepted: January 12, 2022

Published: February 10, 2022

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: https://doi.org/10.1371/journal.pone.0263105

Data Availability Statement: All relevant data are within the paper and its Supporting information files.

Abstract

Introduction

Children from low-resource settings are more likely to encounter those factors that adversely influence their ability to acquire developmental potential. This study was conducted to assess the developmental status and its associated factors among children under five years of slum areas of Butwal Sub Metropolitan City, Rupandehi, Nepal.

Methods and findings

We conducted a community-based cross-sectional descriptive study using Developmental Milestone Chart (DMC) among 165 children under five years. Ethical approval was obtained from Ethical Review Board of Nepal Health Research Council. R software was used for data analysis. The association between developmental status and associated factors were examined with Chi-square and followed by logistic regression. Notably, more than half of the children (56.4%) had delayed development across two or more domains of gross motor, fine motor, language/ speech, and social development. Age, sex, socio-economic status, availability of learning materials, the occurrence of infectious diseases, and height-for-age of children were found to be significantly associated with the developmental status of children under study ($p<0.05$).

Conclusions

More than half of the children taken under the study had delayed development on different four domains. Findings from the study suggest that there should be similar studies conducted among children living in slum-like conditions. Additionally, programs should be designed as such which aims to mitigate the effect of socio-economic status on child development and has learning and nutritional aspects embedded central to its deliverance.

Funding: The author(s) received no specific funding for this work.

Competing interests: The authors have declared that no competing interest exist.

Abbreviations: ARI, Acute Respiratory Infections; DD, Developmental delay; DMC, Developmental Milestone Chart; ECDI, Early Childhood Development Index; IWI, International Wealth Index; LMIC, Low- and middle-income countries.

Introduction

Developmental delay (DD) in a child occurs when the child fails to achieve any one aspect of development; gross motor, fine motor, language/speech, and social development by an appropriate age [1–3]. Developmental status among children is influenced by a range of factors such as socio-economic, biological, maternal, environmental, nutritional, and genetic factors [4–7].

The children living in low-resource settings are more likely to encounter those factors that adversely influence their ability to acquire developmental potential [7–12]. In 2017, around 250 million children living in Low- and middle-income countries (LMIC) were estimated to be at risk of not achieving their full developmental potential [8]. Nearly 38% of the children living in South Asia were estimated to have low developmental scores as per Early Childhood Development Index (ECDI) [13]. The prevalence of suspected DD for ECDI for Nepal was 35.1% among children aged 36–59 months [14]. Healthcare costs associated with children who are at risk of delayed development have been found to be higher than those who are not at risk [15]. A follow-up study found that the majority of the children who were identified to be developmentally delayed at 3 years of age were either under or unemployed, living along with family and financially dependent upon their families and socially isolated [16]. If no timely identification and intervention is applied, children with delayed development living in extremely low resource settings are likely to contribute poorly school performance and subsequently generating low incomes, high fertility, and poor care for their children and eventually resulting to the intergenerational transmission of poverty [17].

According to a United Nations estimation made in 2018, 227 million of the population lived in slums or informal settlements in Southern Asia [18]. Nepal had 49.3% of the population living in slum-like conditions as of 2018 [19]. Nepal being the fastest urbanizing country in South Asia [20]. It may end up generating more slum dwellers, as informal settlements or slums have emerged to be one of the significant challenges for urban development in Nepal [21]. Furthermore, the governments in South Asia are struggling to respond to the already existing scale of growth [22].

The early childhood phase has been identified as the most effective and cost-efficient period to ensure that all children develop their full potential [23, 24]. Also, early childhood investments are claimed to have substantial benefits of preventing disease and promoting health in the long run [25]. Research estimating children at risk of development delay in overall aspects could be essential to highlight the need of interventions and policies targeting early childhood development [26]. Moreover, past studies have shown association between development outcomes and biological and anthropometrical [27], and nutritional factors [28] among children living in Nepal.

Therefore, this study was conducted with the objective to determine the prevalence of DD in four different developmental aspects such as gross motor, fine motor, language/speech, and social development and its associated factors among children under five years living in urban slum areas of Southern Nepal.

Materials and methods

Study design and setting

This was a community-based cross-sectional descriptive study. The data was collected from April to May 2019 among the children under 5 years of age residing in slum areas of Butwal Sub Metropolitan City. This city lies in Rupandehi district of Lumbini province situated 267 k.m. west to the capital city Kathmandu. The metropolitan city has a total population of 170,970 and 40,876 households; while it consists of slums in all its 19 wards as of 2019 [29].

Sample size determination

The total sample size of the study was 165, calculated using Fishers' formula $n = Z^2pq/d^2$ and assuming allowable error ±0.05 at 95 percent confidence level, considering the prevalence of DD among under 5 children in an urban slum (p) 12.2% based on a previous study [2].

Sampling procedure

Of all the 19 wards in Butwal Sub Metropolitan City, five wards with less than 50 slum households were omitted. With 14 wards remaining, 5 wards were selected randomly. Sample estimate was obtained by probability proportional to the slum household size in each ward. Further, the sampling process at each ward was initiated by identifying the center of the catchment area with the help of Google Map version 10.14.1. The household selection was done by spinning a pencil, and the first household was selected in the direction shown by the tip of the pencil. If the selected household didn't have any eligible child, the "nearest door" rule was applied; i.e., adjacent households with the nearest front door. If there were more than one eligible child in the same household, only one child was selected randomly by the lottery method.

Ethical considerations

The study was approved by Ethical Review Board of Nepal Health Research Council. A parental written consent form was obtained before data collection. The parents were well informed about the purpose and objectives of the study, and also were notified that the participation would be voluntary.

Study parameters

Socio-demographic variables included of age in months and sex of children as stated by respondent, family caste-ethnicity division (Dalit, Disadvantaged Janajati, Non-Dalit Disadvantaged, Terai Caste, Religious Minorities, Relatively Advantaged Janajati, Upper Caste Group) based on Health Management Information System of Nepal (HMIS) caste-ethnicity classification [30], family type (nuclear, joint and extended), and socio-economic status based on International Wealth Index (IWI) classification [31] (extremely poor, poor, middle class, upper middle class, rich). Maternal related variables were mother's age at birth, education and occupational level. Maternal educational levels included of attributes like Illiterate, Non-Formal Education, Primary Level, Lower Secondary Level, Secondary Level, Higher Secondary Level, Bachelors, Masters and Above. Mother's occupational status had following categorization as agriculture, business, private/government job, labor, homemaker and others. Environmental characteristics included availability of learning materials for children [32] (yes/no), number of languages used at home (1, 2 and >2), parental alcoholism (yes/no) and smoking (yes/no) on a daily basis. Similarly, biological variables included of birth weight (normal if $\geq$ 2500 gram, underweight $<$ 2500 gram) and history of infectious diseases such as diarrhea, malaria, intestinal parasite, and others in the past six months (yes/no). However, the total number of medically reported histories of infectious diseases in the past six months by the respondents consisted of only Diarrhea, Intestinal Parasites and Acute Respiratory Infections (ARI). Height in centimeters and weight in kilograms were measured to collect anthropometric characteristics. Further, these measures were used to generate anthropometric variables such as weight for height (wasted/normal), weight for age (underweight/normal) and height for age (stunted/normal).

Later, age of the child was categorized into 5 categories as: Less than 1 year that included children from 7 months to 11 months, 1 year included of children from 12 months to 23

months, 2 years included of children from 24 months to 35 months, 3 years included children from 36 months to 47 months and 4 years included children from 48 months to 59 months. Additionally, attributes of some of the variables like family caste-ethnicity, family type, and educational level of mother and occupation of mother were modified and only two attributes were formed at the end. Attributes of family caste-ethnicity like Dalit, Disadvantaged Janajati, Non-Dalit Disadvantaged Terai Caste, and Religious Minorities were added to form Disadvantaged Group and Relatively Advantaged Janajati and Upper Caste Group were added to form Advantaged Group [33]. Similarly, Joint and extended attributes of family type were added together to form only two attributes of nuclear and Joint/Extended. Maternal educational level's attributes like Illiterate, Non-Formal Education, Primary Level, Lower Secondary Level were added to form Below Secondary level and Secondary Level, Higher Secondary Level, Bachelors, Masters and Above were added to form Secondary Level and above. Similarly, Business, Service and Labor attributes of mother's occupation were added together to form only two attributes as Working out of home and Homemaker.

Study tools

Assessment of developmental milestones. DMC was used to assess a child's developmental status in two categories: Delayed and Not Delayed [34]. Gross motor, fine motor, language/speech, and social development are four domains of DMC. Children who did not meet either one or more developmental domains were considered as Developmentally Delayed. Each item in respective domains was answered either as "Yes" if the child has met the potential in a particular domain or "No" if the child has not met the potential yet. Answers for some questions were obtained directly through the mother, while for others certain activities were performed in order to check if the child has met developmental potential. Such activities would be like if the child could describe action in pictures, copies circles, etc.

DMC has been recommended for developmental screening in terms of acceptability, practicality, and implementation as part of child development monitor checkups in a low resource setting [35]. The English Version DMC tool was translated into the Nepali Language by the researcher and was again back-translated into English by a translator. DMC included for this study had 8 different developmental milestones for 8 age groups in months which are: 7–9, 10–12, 13–15, 16–18, 19–23, 24–35, 36–47, and 48–59.

Recommendations for data collection, analysis and reporting on anthropometric indicators in children under 5 years old were used for guidance [36] for taking anthropometric measurements. A Weighing machine, Stature meter and Salter scale were used to collect anthropometric data of children. Height for all children was taken in standing position. Additionally, to measure the economic situation of household and socio-economic status, we included IWI related questions within the questionnaire [31].

Pretesting of tools was done among 10% of the total sample size in the Sinamangal Slum area of Kathmandu Metropolitan City. Minor edits related to grammatical errors were done following the pretesting.

Data collection, management, and analysis

Data collection was done using face to face interviews in the Nepali Language. Anthropometric instruments like the Weighing machine, the Stature meter, and the Salter scale were used for collecting the anthropometric data.

Epidata version 3.1 [37] was used for data entry and R Studio Version 1.1459 [38] and R language Version 3.5.1 [39] software was used for data analysis. Anthropometric data were analyzed using WHO AnthroPlus Version 3.2.2 [40]. The children who scored <-2 SD were

considered underweight (weight for age), stunted (height for age) and wasted (weight for height). Descriptive analysis, calculating frequency and percent for categorical variables and mean or median for continuous variables, was performed. Chi-square test and logistic regression were applied to determine the association between dependent and independent variables. All the statistical tests done were two-tailed and were considered statistically significant for a p-values$<$0.05 at 95% CI. While using logistics models, we adjusted for age of child, sex, family caste-ethnicity, family type, socio-economic status, mother's age at birth of child, educational level, occupation, books available at home, language, parental smoking, parental alcoholism, birth weight, occurrence of infectious diseases in past 6 months, weight for height, weight for age and height for age.

Results

Prevalence of developmental delay

In the study, more than half of the children (56.4%) had delayed development. Prevalence of DD ranged from 8.5% to 34.5% at 4 years and 1 year respectively. Of the total participants, 30.9% of them were found to have delayed development in the social development domain, followed by fine motor (28.5%) and language/speech (28.5%) and gross motor (6.7%) domain.

Socio-demographic characteristics

The age of the children ranged from 7 months to 57 months with the mean age ± SD of 26.5 ±13.4 months. More than half (53.3%) of the children were male. Of the total participants, 66.0% and 64.8% of them belonged to disadvantaged group of family caste-ethnicity and lived in nuclear family type respectively. According to the IWI categorization, 25.5% of children belong to the upper middle class, 55.1% of the children belong to the middle class, while 19.4% of children belong to families with poor wealth index "Table 1".

Table 1. Socio-demographic characteristics.

Socio-demographic characteristics	Total (n)	Percentage (%)
Age of child		
Mean = 26.5 ± 13.4 months		
≤1 year	27	16.4
1 year	57	34.5
2 years	41	24.8
3 years	26	15.8
4 years	14	8.5
Sex		
Female	77	46.7
Male	88	53.3
Family caste-ethnicity		
Advantaged group	56	34.0
Disadvantaged group	109	66.0
Family type		
Nuclear	107	64.8
Joint/Extended	58	35.2
Socio-economic status		
Upper middle class	42	25.5
Middle class	91	55.1
Poor	32	19.4

https://doi.org/10.1371/journal.pone.0263105.t001

Table 2. Maternal characteristics.

Maternal characteristics	Total (n)	Percentage (%)
Mother's age at birth of child		
Mean = 24.1 ± 4.8 years		
< 20 years	40	24.2
20–35 years	123	74.5
> = 36 years	2	1.2
Educational level		
< Secondary level	90	54.5
≥ Secondary level	75	45.5
Occupation		
Homemaker	142	86.1
Working out of home	23	13.9

https://doi.org/10.1371/journal.pone.0263105.t002

Maternal characteristics

Mean age of the mother at birth of the child was 24.1±4.8 years. In terms of educational level, slightly more than half of the mothers (54.5%) were below the secondary level "Table 2".

Environmental characteristics

Of the total 165 children, only 36.4% of the children had learning materials available at home. Children who had parents who smoked or consumed alcohol on a regular basis were 38.2% and 44.2% respectively "Table 3".

Biological and anthropometric characteristics

The majority (86.1%) of children had normal birth weight (> = 2500 gram) with the mean birth weight (kg) 2.9 ± 0.6. Of the total 165 children, 57% of children didn't suffer from any infectious diseases (Diarrhea, Intestinal Parasites, ARI) in the past 6 months. More than 70% of the children had normal weight for height (89.1%), weight for age (86.1%), and height for age (72.7%) "Table 4".

Factors associated with developmental delay

On bivariate analysis, the age of children (p = 0.003) and their socio-economic status (p = 0.049) were associated with their developmental status. Status of availability of learning

Table 3. Environmental characteristics.

Environmental characteristics	Total (n)	Percentage (%)
Books available at home		
No	105	63.6
Yes	60	36.4
Language		
One	121	73.3
Two	44	26.7
Parental smoking		
No	102	61.8
Yes	63	38.2
Parental alcoholism		
No	92	55.8
Yes	73	44.2

https://doi.org/10.1371/journal.pone.0263105.t003

Table 4. Biological and anthropometric characteristics.

Characteristics	Total (n)	Percentage (%)
Biological characteristics		
Birth weight		
Mean = 2.9±0.6 kg		
Normal	142	86.1
Underweight	23	13.9
Occurrence of infectious diseases in past 6 months		
No	94	57.0
Yes	71	43.0
Anthropometric characteristics		
Weight for height		
Normal	147	89.1
Wasted	18	10.9
Weight for age		
Normal	142	86.1
Underweight	23	13.9
Height for age		
Normal	120	72.7
Stunted	45	27.3

https://doi.org/10.1371/journal.pone.0263105.t004

materials for children was associated ($p < 0.001$) with the developmental status. History of infectious diseases in the past six months was found to be associated ($p = 0.027$) with the developmental status of children under study. Anthropometric characteristics like height for the age of children was associated ($p = 0.047$) with developmental status "Table 5".

As per the results obtained, participants who were of one year of age were 3.29 times (AOR, 95% CI, 1.04–10.46) more likely to be developmentally delayed than those who were below one year of age. Female children were 0.43 times (AOR, 95% CI, 0.19–0.99) more likely to have delayed development than male children involved in the study. Children who didn't have any books available at home were 4.00 times (AOR, 95% CI, 1.31–12.26) more likely to be developmentally delayed than those who had learning materials available. Adjusted odds of being developmentally delayed was 3.79 times among children who lived with family using just one language for communication (95% CI, 1.32–10.87) compared to children who lived with family using two languages. Children who suffered from infectious diseases within the past six months of study were 2.18 times more (AOR, 95% CI, 1.01–4.69) at risk of being developmentally delayed compared to children who didn't have any occurrence of infectious disease. Likewise, the odds of being developmentally delayed was 2.07 times higher among children who were stunted (UOR, 95% CI, 1.003–4.28) than those who were normal for height for age "Table 6".

Discussion

Our study showed a high prevalence of DD of 56.4%. Age of children, socio-economic status of family, availability of learning materials at home, the occurrence of infectious diseases in the past six months, and height for age of children were significantly associated with their developmental status.

Findings related to prevalence in our study was much higher as compared to the prevalence rate of other studies done in developed nations [41, 42]. However, in the Nepalese context the suspected DD for Nepal was reported to be 35.1% [14] as per ECDI. One of the possible

Table 5. Association of socio-demographic, environmental, biological and anthropometric characteristics, and developmental status of children (n = 165).

Characteristics	Developmental status		p-value
	Normal (n = 72) n (%)	Delayed (n = 93) n (%)	
Socio-demographic characteristics			
Age of child			**0.003****
≤1 year	11 (40.7)	16 (59.3)	
1 year	14 (24.6)	43 (75.4)	
2 years	24 (60.0)	16 (40.0)	
3 years	15 (57.7)	11 (42.3)	
4 years	8 (57.1)	6 (42.9)	
Mean = 26.5±13.4 months	29.3±13.5	24.3±13.1	**0.016***
Sex			0.284
Male	35 (39.1)	53 (60.9)	
Female	37 (48.1)	40 (51.9)	
Family caste-ethnicity			0.395
Advantaged group	27 (48.2)	29 (51.8)	
Disadvantaged group	45 (41.3)	64 (58.7)	
Family type			0.276
Nuclear	50 (46.7)	57 (53.3)	
Joint/Extended	22 (38.0)	36 (62.0)	
Socio-economic status			**0.049***
Upper middle class	16 (38.1)	26 (61.9)	
Middle class	47 (51.6)	44 (48.4)	
Poor	9 (28.1)	23 (71.9)	
Maternal characteristics			
Mother's age at birth of child			0.470[b]
<20 years	14 (35.0)	26 (65.0)	
20–35 years	57 (53.7)	66 (53.7)	
> = 36 years	1 (50.0)	1 (50.0)	
Mean = 24.1±4.8 years	24.8±4.9	23.6±4.6	0.112[c]
Educational level			0.096
< Secondary level	34 (37.8)	56 (62.2)	
≥ Secondary level	38 (50.7)	37 (49.3)	
Occupation			0.072
Homemaker	58 (40.8)	84 (59.2)	
Working out of home	14 (60.9)	9 (39.1)	
Environmental characteristics			
Books available at home			<**0.001****
No	34 (32.4)	71 (67.6)	
Yes	38 (63.3)	22 (36.7)	
Language			0.523
One	51 (42.1)	70 (57.9)	
Two	21 (47.7)	23 (52.3)	
Parental smoking			0.630
No	46 (45.1)	56 (54.9)	
Yes	26 (41.3)	37 (58.7)	
Parental alcoholism			0.558
No	42 (45.7)	50 (54.3)	
Yes	30 (41.1)	43 (58.9)	

(*Continued*)

Table 5. (Continued)

Characteristics	Developmental status		p-value
	Normal (n = 72) n (%)	Delayed (n = 93) n (%)	
Biological characteristics			
Birth weight			0.639
Normal	63 (44.4)	79 (55.6)	
Underweight	9 (39.1)	14 (60.9)	
Mean = 2.9±0.6 kg	2.9±0.5	2.9±0.6	0.691[c]
Occurrence of infectious diseases in past 6 months			**0.027***
No	48 (51.1)	46 (48.9)	
Yes	24 (33.8)	47 (66.2)	
Anthropometric characteristics			0.151
Weight for height			
Normal	67 (45.6)	80 (54.4)	
Wasted	5 (27.8)	13 (72.2)	
Weight for age			0.169
Normal	65 (45.8)	77 (54.2)	
Underweight	7 (30.4)	16 (69.6)	
Height for age			**0.047***
Normal	58 (48.3)	62 (51.7)	
Stunted	14 (31.1)	31 (68.9)	

p*—Value significant at α <0.05, p**—Value significant at α <0.01, p[b]—Value from Fisher's exact test, p[c]—Value from Independent t-test and all the rest from Chi-square test

https://doi.org/10.1371/journal.pone.0263105.t005

explanations for such high concentration of DD in the present study could be that our study setting was confined to slum areas. And children living in slums are at high health risk exposure [43–45], this might lead to consequences such as delayed development. Similarly, it was found to be higher than prevalence in rural community of Rwanda (52.6%) [46], Ghana (44.6%) [47], China (35.7%) [7], India (16.2%) [48] and Malawi (11.7%) [49].

In the study, the prevalence of DD was significantly higher among 1-year children as compared to other age groups. A study conducted in a similar study setting using the same assessment tool showed similar results of having DD (20.3%) at 12–23 months of age [2]. Further among the socio-demographic variables, association was obtained between the socio-economic status of the family they belonged to and their developmental status. In a study done in China [50] and Iran [1] also found similar results. Likewise, an estimate made in 2017 indicated that children in low and middle-income countries are at risk of not achieving their full developmental potential [8]. This may be due to the relative effect of financial instability [51] on variables such as birth weight, nutritional intake, inter-parental and parent/child interactions, etc., which in turn is known to be affecting the range of child developmental outcomes [52, 53].

Maternal education is an important determinant for child health [54, 55] as it has a positive effect on child health through an increased probability of; use of prenatal care [56], child health service utilization [57], being more receptive to modern medical treatments [58]. However, in the current study there was no significant effect of maternal education on developmental status of children.

Availability of any form of learning materials for children reduces the risk of increasing delayed development among children [50], particularly speech and language skills [48].

Table 6. Factors associated with developmental status of children (n = 165).

Characteristics	Developmental status	
	Unadjusted	Adjusted
	OR (95% CI)	OR (95% CI)
Socio-demographic characteristics		
Age of child		
≤ 1 year	Ref.	Ref.
1 year	2.11 (0.79–5.60)	**3.29 (1.04–10.46)***
2 years	0.49 (0.18–1.31)	0.58 (0.17–1.99)
3 years	0.50 (0.17–1.50)	2.01 (0.42–9.49)
4 years	0.52 (0.14–1.91)	1.36 (0.25–7.39)
Sex		
Male	Ref.	Ref.
Female	0.71 (0.38–1.32)	**0.43 (0.19–0.99)***
Family caste-ethnicity		
Advantaged group	Ref.	Ref.
Disadvantaged group	1.32 (0.69–2.53)	1.75 (0.71–4.34)
Family Type		
Nuclear	Ref.	Ref.
Joint / Extended	1.44 (0.75–2.76)	1.90 (0.80–4.53)
Socio-economic Status		
Upper middle class	Ref.	Ref.
Middle class	0.58 (0.27–1.22)	0.93 (0.36–2.40)
Poor	1.57 (0.58–4.24)	1.38 (0.37–5.17)
Maternal characteristics		
Mother's age at birth of child		
<20 years	1.46 (0.08–25.81)	0.13 (0.003–5.34)
20–35 years	1.27 (0.08–20.67)	0.26 (0.01–9.44)
> = 36 years	Ref.	Ref.
Educational Level		
< Secondary Level	1.69 (0.91–3.15)	2.11 (0.96–4.66)
≥Secondary Level	Ref.	Ref.
Occupation		
Homemaker	Ref.	Ref.
Working out of Home	0.62 (0.31–1.22)	0.60 (0.26–1.41)
Environmental characteristics		
Books available at home		
Yes	Ref.	Ref.
No	**3.61 (1.85–7.02)****	**4.00 (1.31–12.26)***
Language		
One	1.25 (0.63–2.51)	**3.79 (1.32–10.87)***
Two	Ref.	Ref.
Parental Smoking		
No	Ref.	Ref.
Yes	1.17 (0.62–2.21)	1.15 (0.44–2.99)
Parental Alcoholism		
No	Ref.	Ref.
Yes	1.20 (0.65–2.24)	0.94 (0.36–2.50)

(*Continued*)

Table 6. (Continued)

Characteristics	Developmental status	
	Unadjusted	Adjusted
	OR (95% CI)	OR (95% CI)
Biological characteristics		
Birth Weight		
Normal	Ref.	Ref.
Underweight	1.24 (0.50–3.05)	1.68 (0.55–5.14)
Occurrence of Infectious Diseases in past 6 months		
No	Ref.	Ref.
Yes	**2.04 (1.08–3.86)***	**2.18 (1.01–4.69)***
Anthropometric characteristics		
Weight for height		
Normal	Ref.	Ref.
Wasted	2.18 (0.74–6.42)	2.26 (0.32–15.75)
Weight for age		
Normal	Ref.	Ref.
Underweight	1.93 (0.75–4.98)	1.91 (0.30–12.35)
Height for age		
Normal	Ref.	Ref.
Stunted	**2.07 (1.003–4.28)***	1.55 (0.61–3.94)

p*—Value significant at $\alpha < 0.05$, p**—Value significant at $\alpha < 0.001$, All the covariates are adjusted.

https://doi.org/10.1371/journal.pone.0263105.t006

Relevant findings have been obtained in studies in the past supporting this statement [7, 59, 60]. Similarly, our study also revealed that not having any form of learning materials at home for children increased the likelihood of being developmentally delayed in children below five years.

Though many studies have shown there's a strong link between the low birth weight of children with their developmental status [61, 62]. However, children in our study had no consequence of being low weight at birth to their development, which is similar to the findings from the study done among Chinese [7] and Brazilian children [63]. One possible explanation would be the increased reach of obstetric and neonatal care to those children which might have reduced the disadvantages of being born with low weight [64]. However, we lack evidence to support the improved obstetric and neonatal care service provision and service utilization in the current study area [65]. While the children living in low socioeconomic status have high chances of occurrence of infectious diseases given the poor sanitation conditions [1], the occurrence of infectious disease in early years of life can lead to delayed development [66, 67]. We found a similar relation of delayed development among those who suffered infectious disease in past six-months prior to the data collection.

Stunting in early childhood particularly is associated with low cognitive skills, thus affecting developmental status [8, 68, 69]. A study done in rural areas of India showed that malnourished children attained developmental milestones at later age [68]. Similarly, the findings from a study done in LMICs shows that the children are at high-risk of not achieving developmental potential due to stunting [8]. Likewise, our study also indicated that stunting at early years of life is related to increase the odds of being developmentally delayed.

Our study is one of those minimal studies that presents the developmental status of children living in urban slums in Nepal; one of the dimmed areas of developmental aspect for children

from low-resource settings. The tool we used for the study assess the developmental status of a child in four developmental aspects such as gross motor, fine motor, language/ speech, and social development which are one of the major aspects considered primary for any of the developmental tools. However, we had few limitations such as; not having neighborhood and paternal characteristics incorporated within the questionnaire, having relatively small sample size. Also, there could have been a recall bias at times as there were few questions that would require respondents to report; if their child performed any of the activities, weight at birth and occurrence of infectious diseases within the past 6 months. Additionally, use of a cross-sectional study method limits the potential to examine the causal relationship.

Conclusions

Our study found that more than half of the children were found to be developmentally delayed in the study area. Age, socio-economic status, availability of learning materials, occurrence of infectious disease and height for age of children were found to be significantly associated with developmental status of children under study. Findings from the study suggest that investigations need to focus on overall developmental aspects of early childhood development of children. Additionally, programs should be designed as such which aims to mitigate the effect of SES on child development and has learning and nutritional aspects embedded central to its deliverance.

Supporting information

S1 File.
(XLSX)

Acknowledgments

Authors would like to express sincere acknowledgement to Central Institute of Science and Technology College and Butwal Sub-metropolitan City Office for giving permission to conduct research, and Nepal Health Research Council for ethical approval. Authors are grateful to all the parents who gave consent to involve their children and most importantly acknowledge all the children involved in the study.

Author Contributions

Conceptualization: Anupama Bishwokarma.

Data curation: Diwash Shrestha.

Formal analysis: Anupama Bishwokarma, Diwash Shrestha, Kshitiz Bhujel.

Investigation: Anupama Bishwokarma.

Methodology: Anupama Bishwokarma, Isha Karmacharya.

Project administration: Anupama Bishwokarma, Isha Karmacharya.

Supervision: Isha Karmacharya.

Visualization: Diwash Shrestha.

Writing – original draft: Anupama Bishwokarma, Diwash Shrestha, Kshitiz Bhujel, Natasha Chand.

Writing – review & editing: Anupama Bishwokarma, Diwash Shrestha, Kshitiz Bhujel, Natasha Chand, Laxmi Adhikari, Maheshor Kaphle, Ayurma Wagle, Isha Karmacharya.

References

1. Ahmadi Doulabi M, Sajedi F, Vameghi R, Mazaheri MA, Akbarzadeh Baghban AR. Socioeconomic Status Index to Interpret Inequalities in Child Development. Iranian Journal of Child Neurology. 2017; 11: 13–25. https://doi.org/10.22037/ijcn.v11i2.11688 PMID: 28698723
2. Agarwal D, Chaudhary SS, Sachdeva S, Misra SK, Agarwal P. Prevalence of Developmental Delay and Factors Affecting the Development Status among Under 5 Children in an Urban Slum of Agra City. National Journal of Community Medicine. 2018; 9: 474–479.
3. Elella SSAE, Tawfik MAM, Fotoh WMMAE, Barseem NF. Screening for developmental delay in preschool-aged children using parent-completed Ages and Stages Questionnaires: additional insights into child development. Postgraduate Medical Journal. 2017; 93: 597–602. https://doi.org/10.1136/postgradmedj-2016-134694 PMID: 28408725
4. Brown HK, Speechley KN, Macnab J, Natale R, Campbell MK. Mild Prematurity, Proximal Social Processes, and Development. Pediatrics. 2014; 134: e814–e824. https://doi.org/10.1542/peds.2013-4092 PMID: 25113289
5. Crookston BT, Forste R, McClellan C, Georgiadis A, Heaton TB. Factors associated with cognitive achievement in late childhood and adolescence: the Young Lives cohort study of children in Ethiopia, India, Peru, and Vietnam. BMC Pediatrics. 2014; 14: 253. https://doi.org/10.1186/1471-2431-14-253 PMID: 25282338
6. Ali S. A brief review of risk-factors for growth and developmental delay among preschool children in developing countries. Adv Biomed Res. 2013; 2: 91–91. https://doi.org/10.4103/2277-9175.122523 PMID: 24520553
7. Zhang J, Guo S, Li Y, Wei Q, Zhang C, Wang X, et al. Factors influencing developmental delay among young children in poor rural China: a latent variable approach. BMJ Open. 2018; 8: e021628. https://doi.org/10.1136/bmjopen-2018-021628 PMID: 30173158
8. Black MM, Walker SP, Fernald LCH, Andersen CT, DiGirolamo AM, Lu C, et al. Early childhood development coming of age: science through the life course. The Lancet. 2017; 389: 77–90. https://doi.org/10.1016/S0140-6736(16)31389-7 PMID: 27717614
9. Jorgenson AK, Rice J. Urban Slums and Children's Health in Less-Developed Countries. JWSR. 2012; 18: 103–115. https://doi.org/10.5195/jwsr.2012.483
10. Pavlakis AE, Noble K, Pavlakis SG, Ali N, Frank Y. Brain Imaging and Electrophysiology Biomarkers: Is There a Role in Poverty and Education Outcome Research? Pediatric Neurology. 2015; 52: 383–388. https://doi.org/10.1016/j.pediatrneurol.2014.11.005 PMID: 25682481
11. Chugh S. Dropout in Secondary Education: A Study of Children Living in Slums of Delhi. National University of Educational Planning and Administration; 2011.
12. Unger A. Children's health in slum settings. Archives of Disease in Childhood. 2013; 98: 799–805. https://doi.org/10.1136/archdischild-2011-301621 PMID: 23899920
13. McCoy DC, Peet ED, Ezzati M, Danaei G, Black MM, Sudfeld CR, et al. Early Childhood Developmental Status in Low- and Middle-Income Countries: National, Regional, and Global Prevalence Estimates Using Predictive Modeling. PLOS Medicine. 2016; 13: e1002034. https://doi.org/10.1371/journal.pmed.1002034 PMID: 27270467
14. Gil JD, Ewerling F, Ferreira LZ, Barros AJ. Early childhood suspected developmental delay in 63 low- and middle-income countries: Large within- and between-country inequalities documented using national health surveys. J Glob Health. 10. https://doi.org/10.7189/jogh.10.010427 PMID: 32566165
15. Russell MJ, Premji S, Mcdonald S, Zwicker JD, Tough S. Health care service for families with children at early risk of developmental delay: an All Our Families cohort study. Developmental Medicine & Child Neurology. 2020; 62: 338–345. https://doi.org/10.1111/dmcn.14343 PMID: 31469170
16. Keogh BK, Bernheimer LP, Guthrie D. Children With Developmental Delays Twenty Years Later: Where Are They? How Are They? MacLean WE Jr., editor. American Journal on Mental Retardation. 2004; 109: 219–230. PMID: 15072520
17. Grantham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B. Developmental potential in the first 5 years for children in developing countries. The Lancet. 2007; 369: 60–70. https://doi.org/10.1016/S0140-6736(07)60032-4 PMID: 17208643
18. United Nations Statistics Division. SDG Indicators. [cited 28 Sep 2021]. https://unstats.un.org/sdgs/report/2019/Goal-11/.

19. United Nations Human Settlements Programme (UN-HABITAT). Population living in slums (% of urban population)—Nepal | Data. [cited 28 Sep 2021]. https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS?locations=NP.

20. Muzzini E, Aparicio G. Urban Growth and Spatial Transition in Nepal: An Initial Assessment. Washington, DC: World Bank; 2013 Mar.

21. Devkota K. Challenges of inclusive urbanization in the face of political transition in Nepal. Handbook of research on urban governance and management in the developing world. IGI Global; 2018. pp. 159–171.

22. Elsey H, Thomson DR, Lin RY, Maharjan U, Agarwal S, Newell J. Addressing inequities in urban health: do decision-makers have the data they need? Report from the urban health data special session at international conference on urban health Dhaka 2015. Journal of Urban Health. 2016; 93: 526–537. https://doi.org/10.1007/s11524-016-0046-9 PMID: 27184570

23. Engle PL, Fernald LC, Alderman H, Behrman J, O'Gara C, Yousafzai A, et al. Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries. The Lancet. 2011; 378: 1339–1353. https://doi.org/10.1016/S0140-6736(11)60889-1 PMID: 21944378

24. Wodon Q. Investing in Early Childhood Development: Essential Interventions, Family Contexts, and Broader Policies. Journal of Human Development and Capabilities. 2016; 17: 465–476. https://doi.org/10.1080/19452829.2016.1240883

25. Campbell F, Conti G, Heckman JJ, Moon SH, Pinto R, Pungello E, et al. Early Childhood Investments Substantially Boost Adult Health. Science. 2014; 343: 1478–1485. https://doi.org/10.1126/science.1248429 PMID: 24675955

26. Richter LM, Daelmans B, Lombardi J, Heymann J, Boo FL, Behrman JR, et al. Investing in the foundation of sustainable development: pathways to scale up for early childhood development. The Lancet. 2017; 389: 103–118. https://doi.org/10.1016/S0140-6736(16)31698-1 PMID: 27717610

27. Ranjitkar S, Hysing M, Kvestad I, Shrestha M, Ulak M, Shilpakar JS, et al. Determinants of Cognitive Development in the Early Life of Children in Bhaktapur, Nepal. Frontiers in Psychology. 2019; 10: 2739. https://doi.org/10.3389/fpsyg.2019.02739 PMID: 31920798

28. Kang Y, Aguayo VM, Campbell RK, West KP Jr.. Association between stunting and early childhood development among children aged 36–59 months in South Asia. Maternal & Child Nutrition. 2018; 14: e12684. https://doi.org/10.1111/mcn.12684 PMID: 30499257

29. Butwal Sub-metropolitan City. Butwal Sub-metropolitan City Profile. In: bsmc profile.pdf [Internet]. 2019 [cited 28 Sep 2021]. https://drive.google.com/file/d/1-6HAxCFz7ShGxNRB0Z54K4je2_wJ2jNk/view?usp=embed_facebook.

30. Bennett L. Caste, ethnic, and regional identity in Nepal: further analysis of the 2006 Nepal Demographic and Health Survey. Population Division, Ministry of Health and Population, Government of Nepal; 2008.

31. Smits J, Steendijk R. The International Wealth Index (IWI). Social Indicators Research: An International and Interdisciplinary Journal for Quality-of-Life Measurement. 2015; 122: 65–85.

32. Jeong J, McCoy DC, Fink G. Pathways between paternal and maternal education, caregivers' support for learning, and early child development in 44 low- and middle-income countries. Early Childhood Research Quarterly. 2017; 41: 136–148. https://doi.org/10.1016/j.ecresq.2017.07.001

33. Paudel D. Trends and Determinants of Neonatal Mortality in Nepal: Further Analysis of the Nepal Demographic and Health Survey, 2001–2011. Ministry of Health and Population; 2013. https://dhsprogram.com/pubs/pdf/FA75/FA75.pdf.

34. Scherzer AL. Experience in Cambodia With the Use of a Culturally Relevant Developmental Milestone Chart for Children in Low- and Middle-Income Countries: Recording Childhood Milestones in Developing Countries. Journal of Policy and Practice in Intellectual Disabilities. 2009; 6: 287–292. https://doi.org/10.1111/j.1741-1130.2009.00234.x

35. Karim T MBBS, MPH, Scherzer A MD, EdD, FAAP, Muhit M MBBS, MSc, MSc (Ophth), PhD, Badawi N MBBCh, DCH, MSc, PhD, FRCPI, FRACP, Khandaker G MBBS, DCH, MPH, PhD, FAFPHM. Use of a Developmental Milestone Chart (DMC) in Rural Bangladesh to Educate Health Workers and Stimulate Referral for Early Diagnosis and Intervention. Journal of Tropical Pediatrics. 2019; 65: 505–509. https://doi.org/10.1093/tropej/fmy073 PMID: 30590812

36. Recommendations for data collection, analysis and reporting on anthropometric indicators in children under 5 years old. World Health Organization and the United Nations Children's Fund (UNICEF); 2019. https://apps.who.int/iris/bitstream/handle/10665/324791/9789241515559-eng.pdf?ua=1.

37. Lauritsen J, Bruus BM. EpiData Entry (3.1). A comprehensive tool for validated entry and documentation of data. Denmark: Epidata Association; 2019. https://epidata.dk/download.php.

38. RStudio | Open source & professional software for data science teams. [cited 28 Sep 2021]. https://rstudio.com/.

39. The R Foundation. R: The R Project for Statistical Computing. [cited 28 Sep 2021]. https://www.r-project.org/.

40. Growth reference 5–19 years—Application tools. [cited 28 Sep 2021]. https://www.who.int/tools/growth-reference-data-for-5to19-years/application-tools.

41. Valla L, Wentzel-Larsen T, Hofoss D, Slinning K. Prevalence of suspected developmental delays in early infancy: results from a regional population-based longitudinal study. BMC Pediatrics. 2015; 15: 215. https://doi.org/10.1186/s12887-015-0528-z PMID: 26678149

42. Rosenberg SA, Zhang D, Robinson CC. Prevalence of Developmental Delays and Participation in Early Intervention Services for Young Children. Pediatrics. 2008; 121: e1503–e1509. https://doi.org/10.1542/peds.2007-1680 PMID: 18504295

43. Fink G, Günther I, Hill K. Slum Residence and Child Health in Developing Countries. Demography. 2014; 51: 1175–1197. https://doi.org/10.1007/s13524-014-0302-0 PMID: 24895049

44. Organization WH. Global report on urban health: equitable healthier cities for sustainable development. 2016.

45. Das MK, Seth S, Mundeja N, Singh AK, Mukherjee SB, Juneja M, et al. Promoting family integrated early child development (during first 1000 days) in urban slums of India (fine child 3-3-1000): Study protocol. Journal of Advanced Nursing. 2020; 76: 1823–1830. https://doi.org/10.1111/jan.14384 PMID: 32281161

46. Ahishakiye A, Abimana MC, Beck K, Miller AC, Betancourt TS, Magge H, et al. Developmental Outcomes of Preterm and Low Birth Weight Toddlers and Term Peers in Rwanda. Ann Glob Health. 85. https://doi.org/10.5334/aogh.2629 PMID: 31871910

47. Bello AI, Quartey JN, Appiah LA. Screening for developmental delay among children attending a rural community welfare clinic in Ghana. BMC Pediatr. 2013; 13: 119. https://doi.org/10.1186/1471-2431-13-119 PMID: 23937954

48. Sharma N, Masood J, Singh SN, Ahmad N, Mishra P, Singh S, et al. Assessment of risk factors for developmental delays among children in a rural community of North India: A cross-sectional study. J Educ Health Promot. 2019; 8. PMID: 31334264

49. Murphy R, Jolley E, Lynch P, Mankhwazi M, Mbukwa J, Bechange S, et al. Estimated prevalence of disability and developmental delay among preschool children in rural Malawi: Findings from "Tikule Limodzi," a cross-sectional survey. Child: Care, Health and Development. 2020; 46: 187–194. https://doi.org/10.1111/cch.12741 PMID: 31925814

50. Wei QW, Zhang JX, Scherpbier RW, Zhao CX, Luo SS, Wang XL, et al. High prevalence of developmental delay among children under three years of age in poverty-stricken areas of China. Public Health. 2015; 129: 1610–1617. https://doi.org/10.1016/j.puhe.2015.07.036 PMID: 26318615

51. Emerson E, Savage A, Llewellyn G. Significant cognitive delay among 3- to 4-year old children in low- and middle-income countries: prevalence estimates and potential impact of preventative interventions. International Journal of Epidemiology. 2018; 47: 1465–1474. https://doi.org/10.1093/ije/dyy161 PMID: 30085108

52. Conger RD, Donnellan MB. An Interactionist Perspective on the Socioeconomic Context of Human Development. Annu Rev Psychol. 2007; 58: 175–199. https://doi.org/10.1146/annurev.psych.58.110405.085551 PMID: 16903807

53. Brooks-Gunn J, Duncan GJ. The effects of poverty on children. Future Child. 1997; 7: 55–71. PMID: 9299837

54. Chen Y, Li H. Mother's education and child health: Is there a nurturing effect? Journal of Health Economics. 2009; 28: 413–426. https://doi.org/10.1016/j.jhealeco.2008.10.005 PMID: 19058866

55. Güneş PM. The role of maternal education in child health: Evidence from a compulsory schooling law. Economics of Education Review. 2015; 47: 1–16. https://doi.org/10.1016/j.econedurev.2015.02.008

56. Currie J, Moretti E. Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings*. The Quarterly Journal of Economics. 2003; 118: 1495–1532. https://doi.org/10.1162/003355303322552856

57. Patel PN, Hada M, Carlson BF, Boulton ML. Immunization status of children in Nepal and associated factors, 2016. Vaccine. 2021; 39: 5831–5838. https://doi.org/10.1016/j.vaccine.2021.08.059 PMID: 34456076

58. Glewwe P. Why Does Mother's Schooling Raise Child Health in Developing Countries? Evidence from Morocco. The Journal of Human Resources. 1999; 34: 124–159. https://doi.org/10.2307/146305

59. Wu TC, Shi HF, Du YF, Zhang JX, Zhao CX, Huang XN, et al. Effect of books and toys on early childhood development in poor rural areas of China. Zhonghua Er Ke Za Zhi. 2019; 57: 187–193. https://doi.org/10.3760/cma.j.issn.0578-1310.2019.03.006 PMID: 30818895

60. Zhang C, Zhao C, Liu X, Wei Q, Luo S, Guo S, et al. Inequality in early childhood neurodevelopment in six poor rural counties of China: a decomposition analysis. International journal for equity in health. 2017; 16. https://doi.org/10.1186/s12939-017-0691-y PMID: 29221451

61. Huang C, Martorell R, Ren A, Li Z. Cognition and behavioural development in early childhood: the role of birth weight and postnatal growth. Int J Epidemiol. 2013; 42: 160–171. https://doi.org/10.1093/ije/dys207 PMID: 23243117

62. Oudgenoeg-Paz O, Mulder H, Jongmans MJ, van der Ham IJM, Van der Stigchel S. The link between motor and cognitive development in children born preterm and/or with low birth weight: A review of current evidence. Neuroscience & Biobehavioral Reviews. 2017; 80: 382–393. https://doi.org/10.1016/j.neubiorev.2017.06.009 PMID: 28642071

63. Halpern R, Barros AJD, Matijasevich A, Santos IS, Victora CG, Barros FC. Developmental status at age 12 months according to birth weight and family income: a comparison of two Brazilian birth cohorts. Cad Saúde Pública. 2008; 24: s444–s450. https://doi.org/10.1590/s0102-311x2008001500010 PMID: 18797720

64. Goisis A, Özcan B, Myrskylä M. Decline in the negative association between low birth weight and cognitive ability. PNAS. 2017; 114: 84–88. https://doi.org/10.1073/pnas.1605544114 PMID: 27994141

65. Annual Report- 2076/77 (2019/20). Department of Health Services, Ministry of Health and Population, Government of Nepal; 2021. https://dohs.gov.np/wp-content/uploads/2021/07/DoHS-Annual-Report-FY-2076-77-for-website.pdf.

66. Pinkerton R, Oriá RB, Lima AAM, Rogawski ET, Oriá MOB, Patrick PD, et al. Early Childhood Diarrhea Predicts Cognitive Delays in Later Childhood Independently of Malnutrition. Am J Trop Med Hyg. 2016; 95: 1004–1010. https://doi.org/10.4269/ajtmh.16-0150 PMID: 27601523

67. Niehaus MD, Moore SR, Patrick PD, Derr LL, Lorntz B, Lima AA, et al. Early childhood diarrhea is associated with diminished cognitive function 4 to 7 years later in children in a northeast Brazilian shantytown. The American journal of tropical medicine and hygiene. 2002; 66: 590–593. https://doi.org/10.4269/ajtmh.2002.66.590 PMID: 12201596

68. Vazir S, Naidu AN, Vidyasagar P. Nutritional status, psychosocial development and the home environment of Indian rural children. Indian Pediatr. 1998; 35: 959–966. PMID: 10216718

69. Walker SP, Chang SM, Powell CA, Grantham-McGregor SM. Effects of early childhood psychosocial stimulation and nutritional supplementation on cognition and education in growth-stunted Jamaican children: prospective cohort study. The Lancet. 2005; 366: 1804–1807. https://doi.org/10.1016/S0140-6736(05)67574-5 PMID: 16298218