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Research article

Age and gender-related differences in quality of life of Bangladeshi patients with Down Syndrome: A cross-sectional study

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ABSTRACT

Currently available screening instruments for evaluation of individuals with intellectual disabilities do not capture all the complications associated with Down Syndrome (DS). Here, we examined age and gender-specific variability revolving around major challenges related to ophthalmologic and auditory health, social integration, daily life, and behavioral problems in 468 (age: 2–84 years) individuals with DS living in all eight divisions of Bangladesh. More than half of the children presented with significant difficulty in walking or other targeted movements compared with 37.9% of adolescents ($p = 0.03$). Nearly 70% of children exhibited communication difficulties, particularly revolving around the understanding of speech, comprehending or learning tasks or new materials, and in expressing thoughts in words or behaviors ($p = 0.003$–0.006). Uncontrolled urination was frequent and predominantly found among children ($p = 0.04$). No significant differences were present in females vs. males except for concern about physical appearance (females: 58.5% vs. males: 47.5%; $p = 0.02$). The severity of DS was associated with intellectual performance, communication difficulties, and self-sufficiency (i.e., uncontrolled micturition or bowel movements) but not with psychotic, ophthalmologic, auditory, or motor skills-related problems. Increased awareness of DS phenotypic profiles among professionals and caregivers can foster earlier detection and counselling and help formulate appropriate interventions to reduce long-term sequelae and enhance cognitive and behavioral developmental outcomes.

1. Introduction

Down Syndrome (DS) (or Trisomy 21) is a prevalent genetic syndrome caused by aberrant chromosomal segregation during birth resulting in an extra copy of chromosome 21, which in turn causes a number of structural and behavioral challenges throughout the lifespan of affected individuals [1, 2, 3, 4]. DS occurs in 14 of every 10,000 live births globally and its incidence is increased with advancing maternal age [5].

Patients with DS are frequently predisposed to a number of early-onset complications, such that challenges and medical issues are more prevalent among children and adolescents than among adults with DS [6, 7]. Visual impairment, hearing loss, hyperactivity/inattention, learning disability, and delayed speech and language are the most common disabilities among individuals with DS. However, the phenotypic variance of these difficulties is high from one patient to another and highly dependent on several factors such as age, sex, time of diagnosis, and access to treatment [8, 9, 10]. Moreover, patients with DS are also at increased risk of recurrent episodic illnesses, respiratory infections, gastrointestinal diseases, obstructive sleep apnea, Alzheimer's disease, and congenital heart diseases (CHD), all of which often lead to earlier age mortality when compared to unaffected individuals or people with other disabilities [10, 11]. Interestingly, female patients appear to manifest less repetitive and externalizing behaviors than males [12], even though the life expectancy in male patients with DS is higher [13].

Comprehensive health assessment programs, health-check interventions, and national level health guidelines and recommendations are the unmet needs to support the patients with DS [10]. Furthermore, lifelong social, emotional, financial, and educational supports are often required to care for patients with DS. However, these supportive

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initiatives are often interrupted by the poor understanding of diseases mechanisms, prognosis, and lack of universal predictors of age and gender-specific behavioral differences and level of disability in DS and health inequalities resulting from the economic gap in different countries [14]. Moreover, prior studies focusing on the behavioral challenges in DS are limited by analyzing a few specific behaviors, low sample size, and inclusion of patients with other intellectual disabilities that impose additional challenges to understand behavioral symptoms and adapt countermeasures [15, 16, 17, 18]. Thus, the concerning obstacles in research and healthcare are leaving many patients with DS with no access to medical check-ups despite having multiple medical complications, and the cases for developing countries are more concerning [18, 19]. As a result, more standard predictors are needed to capture the behavioral problems and challenges for patients with DS to recommend timely and more effective medical and other supportive measures.

Bangladesh, a developing country of Southeast Asia with more than 160 million people, is estimated to have approximately two hundred thousand citizens with DS [20]. Although several studies have been carried out on patients with DS from countries such as Finland, Hong Kong, Israel, Norway, Australia, no study in Bangladesh has assessed their quality of life (QoL), major daily life challenges, and behavioral problems to date. Consequently, the knowledge gap resulting from the lack of any available evidence in Bangladesh is likely to result in a heightened burden to individuals with disabilities and their families.

In this population-based cross-sectional study, we sought to explore the age and gender-specific behavioral problems and challenges related to eyesight and auditory health, social integration, and daily life in a large sample of people with DS living in Bangladesh. Moreover, we also analyzed the potential relationships between symptoms and the level of disability.

2. Methodology

2.1. Study design and sampling

This was a population-based cross-sectional study among DS subjects aged between 2 and 84 years. The structured questionnaire was at first piloted in 12 Upazilas of the Gopalganj district and including Jamalpur Sadar, Barisal Sadar; Barura (Comilla), Paba (Rajshahi), Morrelganj (Bagerhat), Fulbari (Dinajpur), Chunarughat (Habiganj), and two urban community developments (UCD) to refine the study tools. In compliance with the declaration of Helsinki, trained research personnel and investigators conducted the survey using face-to-face interviews with patients with DS (n = 383, 81.84%) or their family members (n = 85, 18.16%). These interviews obtained information on demographics, along with twenty-four disability-related questions with appropriate response options. The level of disability was determined by the consulting physicians with experience in the evaluation and clinical management of DS and was designated by the Directorate General of Health Services.

Considering an estimated prevalence of DS of around 0.125% in Bangladesh [20], the minimum sample size was estimated at 168 to ensure 95% confidence intervals and a 5% margin of error. The social and health records of the study subjects were accessed from the Dept. of Social Welfare, Ministry of Social Welfare of Bangladesh that contained psychological, educational, medical, and social records of 4,770 people with DS surveyed between 2018 to September 2020 (https://www.dis.gov.bd/). However, data curation that consisted of omitting outliers and missing values led to a random selection of 468 DS subjects from the curated dataset resided in all eight divisions and 59 out of 64 districts of Bangladesh.

2.2. Definition and classification

Age was classified into three groups: child (0–9 years), adolescent (10–19 years), and adult (≥20 years) based on the World Health Organization (WHO) classification [21]. The severity of DS was classified based on the severity of intellectual disability (ID) into mild, moderate, and severe that represented IQ scores of 50–69, 35–50, and 20–35, respectively [2, 3].

2.3. Ethical considerations

Ethical approval was secured from the Bio-safety, Bio-security and Ethical Committee, Faculty of Biological Sciences, Jahangirnagar University (Ref. No: BBEC, JU/M 2020(10)4). Written informed consent was obtained from the families of people with DS prior to their participation in this study. The participants were fully appraised about the purpose of the study. Anonymity, confidentiality, and voluntary participation with no monetary benefit were ensured, including the option to withdraw at any time from the study.

2.4. Statistical analyses

Data were analyzed using IBM SPSS Statistics version 26.0 for windows (Chicago IL). Descriptive statistics (e.g., frequencies, percentages, means, standard deviations, etc.) were computed. In addition, inferential statistics, including t-tests or one-way ANOVA tests, were performed to determine the significant relationship of the predicted disability items with age and gender. Furthermore, the associations between disability-related items with the severity of the disorder were also evaluated. In the case of categorical variables, chi-square tests were performed. The level of significance of each result was set at 2-sided $p < 0.05$. The research methodology is summarized in Figure 1.

3. Results

3.1. Demographic characteristics of the subjects

A total of 468 DS subjects aged between 2-84 years were included in this study (males: 263). Mean age of female participants was 18.2 ± 15.4 years and was 16.2 ± 12.4 years for males (Table 1), with 151 subjects being aged between 1-9 years, 182 subjects between 10-19 years, and 135 subjects aged ≥20 years. Significant differences ($p < 0.001$) were observed in subjects' marital status, education level, occupation, and annual income among different age groups, where higher percentage of married (65.9%), literate (14.8%), having occupation (37.8%), and having annual income <24000 BDT (8.9%) were predominantly found for subjects aged ≥20 years compared to subjects of other two age groups. However, no significant differences were recorded among different age groups regarding religion, type of residence, family history of DS, dependence on others, and adverse experiences from others. The majority of the subjects among all age groups resided in rural areas, depend on others for their care, and had no family history of DS and no record of sustaining adverse behaviors from others.

The vast majority was single (87.8% in male vs. 90.2% in female), illiterate (85.9% in male vs. 88.8% in female), had no professional occupation (83.7% in male vs. 88.3% in female), had no sources of income (93.9% in male vs. 98% in female), were Muslim (90.5% in male vs. 89.3% in female), resided in rural areas (86.3% in male vs. 85.9% in female), had no family history of DS (91.6% in male vs. 93.2% in female), were dependent on others (71.1% in male vs. 77.6% in female), and had no previous history of teasing, physical, mental, sexual, or social harassment (97% in male vs. 96.6% in female) (Table 1).

3.2. Down Syndrome and learning-related problems

Table 2 depicts the frequency of twenty-four different disability-related items under the terms: motor-skills; ophthalmologic and auditory; learning; behavioral-related; and other concerns among different age groups and gender. Overall, the Cronbach alpha for twenty-four items was found to be 0.84, which was considered good. Positive responses were mostly observed in learning-related items, while the least

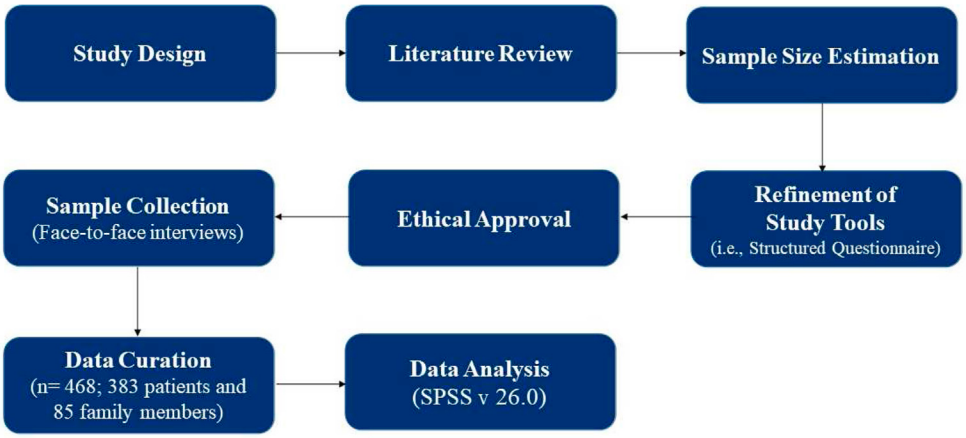

Figure 1. Research methodology flowchart of this study.

Table 1. Demographic characteristics of subjects with Down Syndrome by age and gender.

	Age groups				Sex		
	1–9 years (n = 151)	10–19 years (n = 182)	≥20 years (n = 135)	p	Male (n = 263)	Female (n = 205)	p
Age (mean)	6.24 ± 1.98	13.79 ± 2.80	34.66 ± 15.13	<0.001	18.25 ± 15.40	16.25 ± 12.42	0.13
Marital status							
Single	148 (98%)	179 (98.4%)	89 (65.9%)	<0.001	231 (87.8%)	185 (90.2%)	0.41
Married	03 (2%)	03 (1.6%)	46 (34.1%)		32 (12.2%)	20 (9.8%)	
Education level							
Illiterate	145 (96%)	158 (86.8%)	105 (77.8%)	<0.001	226 (85.9%)	182 (88.8%)	0.17
Literate	06 (4%)	18 (9.9%)	20 (14.8%)		27 (10.3%)	17 (8.3%)	
Below SSC	0 (0%)	05 (2.7%)	06 (4.4%)		5 (1.9%)	6 (2.9%)	
SSC and above	0 (0%)	01 (0.5%)	04 (3%)		5 (1.9%)	0 (0%)	
Occupation							
None	147 (97.4%)	170 (93.4%)	84 (62.2%)	<0.001	220 (83.7%)	181 (88.3%)	0.08
Agriculture	0 (0%)	02 (1.1%)	07 (5.2%)		08 (3%)	01 (0.5%)	
Business	0 (0%)	01 (0.5%)	13 (9.6%)		06 (2.3%)	08 (3.9%)	
Artist	03 (2%)	09 (4.9%)	25 (18.5%)		23 (8.7%)	14 (6.8%)	
House-work	01 (0.7%)	0 (0%)	06 (4.4%)		06 (2.3%)	01 (0.5%)	
Annual income (BDT)							
Not Applicable	148 (98%)	181 (99.5%)	119 (88.1%)		247 (93.9%)	201 (98%)	0.06
<24,000	01 (0.7%)	01 (0.5%)	12 (8.9%)	<0.001	12 (4.6%)	02 (1%)	
≥24,000	02 (1.3%)	0 (0%)	04 (3%)		04 (1.5%)	02 (1%)	
Religion							
Islam	138 (91.4%)	162 (89%)	121 (89.6%)	0.12	238 (90.5%)	183 (89.3%)	0.43
Hindu	12 (7.9%)	08 (4.4%)	09 (6.7%)		17 (6.5%)	12 (5.9%)	
Buddhist	0 (0%)	09 (4.9%)	04 (3%)		07 (2.7%)	06 (2.9%)	
Christian	01 (0.7%)	03 (1.6%)	01 (0.7%)		01 (0.4%)	04 (2%)	
Residence							
Urban	18 (11.9%)	27 (14.8%)	20 (14.8%)	0.69	36 (13.7%)	29 (14.1%)	0.89
Rural	133 (88.1%)	155 (85.2%)	115 (85.2%)		227 (86.3%)	176 (85.9%)	
Family history of DS							
Yes	06 (4%)	17 (9.3%)	13 (9.6%)		22 (8.4%)	14 (6.8%)	0.54
No	145 (96%)	165 (90.7%)	122 (90.4%)	0.11	241 (91.6%)	191 (93.2%)	
Dependent							
Yes	120 (79.5%)	129 (70.9%)	97 (71.9%)	0.16	187 (71.1%)	159 (77.6%)	0.11
No	31 (20.5%)	53 (29.1%)	38 (28.1%)		76 (28.9%)	46 (22.4%)	
Harassment							
No	150 (99.3%)	177 (97.3%)	126 (93.3%)	0.59	255 (97%)	198 (96.6%)	0.4
Physical	01 (0.7%)	04 (2.2%)	06 (4.4%)		07 (2.7%)	4 (2.0%)	
Mental	0 (0%)	01 (0.5%)	03 (2.2%)		01 (0.4%)	3 (1.5%)	

Table 2. Frequency of disability-related symptoms among Down Syndrome subjects by age and gender.

	Age groups				Gender		
	01–09 years (n = 151)	10–19 years (n = 182)	≥20 years (n = 135)	*p*	Male (n = 263)	Female (n = 205)	*p*
Ophthalmologic and auditory related							
Eyesight problems	11.3%	9.9%	15.6%	0.29	10.3%	14.1%	0.20
Eyesight problems during day or night compared to others	14.6%	9.9%	11.1%	0.40	11.4%	12.2%	0.79
Hearing problems	16.6%	18.1%	19.3%	0.84	17.1%	19%	0.59
Motor skills-related							
Difficulty in walking or any other movements	51.7%	37.9%	48.1%	**0.03**	47.1%	42.9%	0.36
Difficulties in self-cleaning or wearing clothes	56.3%	48.4%	44.4%	0.12	49.4%	50.2%	0.86
Feeling of weakness/stiffness in hands and legs during walking or moving hands	47%	37.9%	50.4%	0.06	46.4%	42%	0.34
Difficulty in standing, sitting, bending, lifting, any other movement, or walking compared to others	49.7%	39%	45.2%	0.14	44.9%	43.4%	0.75
Repetitive action (e.g., continuously moving hands, shaking head)	12.6%	13.2%	17%	0.50	15.2%	12.7%	0.44
Tendency of being blackout/faint or stiff, or having epilepsy	3.3%	7.7%	5.2%	0.22	6.5%	4.4%	0.33
Learning related							
Difficulty in understanding or learning than others of the same age	**73.5%**	**68.1%**	**54.8%**	**0.003**	66.2%	65.9%	0.94
Difficulty or delay in understanding verbal speeches	**73.5%**	**65.9%**	**54.1%**	**0.003**	64.6%	65.4%	0.87
Difficulty to express own thoughts in words or behavior	**69.5%**	**67%**	**52.6%**	**0.006**	63.9%	63.4%	0.92
Difficulty to play a fancy game with a toy or other things	28.5%	23.1%	21.5%	0.34	21.7%	27.8%	0.13
Psychiatric or behavior-related							
Difficulty in making eye contact	45.7%	42.3%	47.4%	0.65	43.3%	46.8%	0.45
Tendency to stay alone	17.9%	26.4%	29.6%	**0.05**	24%	25.4%	0.73
Tendency to laugh/cry alone	17.2%	20.3%	20.7%	0.70	18.6%	20.5%	0.62
Saying the same thing repeatedly	19.2%	17.6%	22.2%	0.59	18.3%	21%	0.46
Visual or auditory hallucinations	25.2%	22%	23%	0.79	23.6%	22.9%	0.87
Reserved or infuriated due to any irrational anxiety or fear	26.5%	25.3%	20.7%	0.49	21.3%	28.3%	0.08
Angry or destructive for no reason	22.5%	29.7%	23.7%	0.27	25.9%	25.4%	0.90
Tendency to harm/hit self or others	17.2%	18.1%	16.3%	0.91	16%	19%	0.39
Other concerns							
Face or physique seem different from others	52.3%	50.5%	54.8%	0.75	47.5%	58.5%	**0.02**
Uncontrolled urination/bowel movements creating an uncomfortable situation	26.5%	17%	15.6%	**0.04**	17.5%	22.4%	0.18
Trouble in sleeping	11.3%	15.9%	16.3%	0.38	15.2%	13.7%	0.64

Bold indicates statistical significance.

frequent responses were observed in items related to ophthalmologic and auditory concerns, irrespective of age and gender (Table 2).

Regarding motor skills-related problems, significant differences ($p = 0.03$) emerged among the age groups, where 51.7% of children reported having difficulty in walking or any other movements, while only 37.9% of adolescents reported these issues. For the other items under motor skills-related problems, positive responses among different age groups and gender were observed within the range of 35%–55%, with a few exceptions related to involuntary movements and epilepsy (Table 2).

More than 50% reported learning difficulties in three out of the four items, irrespective of age groups or gender. Most importantly, significant differences ($p = 0.003$–0.006) were observed among different age groups in case of the following three items – "Difficulty in understanding or learning than others of the same age", "Difficulty or delay in understanding verbal speeches", and "Difficulty to express own thoughts in words or behavior", where positive responses were recorded among nearly 70% of children. However, for the item termed "Difficulty to play a fancy game with a toy or other things", the frequency of positive responses across the different groups was found as less than 30%. The frequency of positive responses was also less than 30% among all the items under behavioral-related problems in the different groups. Self-injurious and combative behaviors were more common in females and in the younger subjects compared to their male counterparts and other age-groups, respectively.

Among the other concerns, the majority (>50%) of the study subjects reported that their physique or face seems different from others.

Table 3. Comparison of self-reported vs. family-reported responses to disability-related symptoms.

Characteristics	Total $N = 468$		Self-reported		Family-reported		χ^2	*df*	*p*- value
	n	(%)	*n*	(%)	*n*	(%)			
Ophthalmologic and auditory related									
Eyesight problems									
Yes	56	(12)	43	(11.2)	13	(15.3)	1.092	1	.354
No	412	(88)	340	(88.8)	72	(84.7)			
Eyesight problems during day or night compared to others									
Yes	55	(11.8)	45	(11.7)	10	(11.8)	.000	1	1.000
No	413	(81.2)	338	(88.3)	75	(88.2)			
Hearing problems									
Yes	84	(17.9)	71	(18.5)	13	(15.3)	.497	1	.535
No	384	(82.1)	312	(81.5)	72	(84.7)			
Motor skills-related									
Difficulty in walking or any other movements									
Yes	212	(45.3)	169	(44.1)	43	(50.6)	1.173	1	.282
No	256	(54.7)	214	(55.9)	42	(49.4)			
Difficulties in self-cleaning or wearing clothes									
Yes	233	(49.8)	185	(48.3)	48	(56.5)	1.856	1	.188
No	235	(50.2)	198	(51.7)	37	(43.5)			
Feeling of weakness/stiffness in hands and legs during walking or moving hands									
Yes	208	(44.4)	168	(43.9)	40	(47.1)	0.288	1	.630
No	260	(55.6)	215	(56.1)	45	(52.9)			
Difficulty in standing, sitting, bending, lifting, other movement, or walking compared to others									
Yes	207	(44.2)	169	(44.1)	38	(44.7)	0.010	1	1.000
No	261	(55.8)	214	(55.9)	47	(55.3)			
Repetitive action (e.g., continuously moving hands, shaking head)									
Yes	66	(14.1)	50	(13.1)	16	(18.8)	1.911	1	.171
No	402	(85.9)	333	(86.9)	69	(61.2)			
Tendency of being blackout/faint or stiff, or having epilepsy									
Yes	26	(5.6)	22	(5.7)	4	(4.7)	.143	1	1.000
No	442	(94.4)	361	(94.3)	81	(95.3)			
Learning related									
Difficulty in understanding/learning than others of the same age									
Yes	309	(66.0)	245	(64.0)	64	(75.3)	3.978	1	.057
No	159	(34.0)	138	(36.0)	21	(24.7)			
Difficulty or delay in understanding verbal speeches									
Yes	304	(65.0)	237	(61.9)	67	(78.8)	8.773	1	**.004**
No	164	(35.0)	146	(38.1)	18	(21.2)			
Difficulty to express own thoughts in words or behavior									
Yes	298	(63.7)	230	(60.1)	68	(80.0)	11.967	1	**.000**
No	170	(36.3)	153	(39.9)	17	(20.0)			
Difficulty to play a fancy game with a toy or other things									
Yes	114	(24.4)	83	(21.7)	31	(36.5)	8.269	1	**.005**
No	354	(76.6)	300	(78.3)	54	(63.5)			
Psychotic or behavioral-related									
Difficulty in making eye contact									
Yes	210	(44.9)	162	(42.3)	48	(56.5)	5.649	1	**.022**
No	258	(55.1)	221	(57.7)	37	(43.5)			
Tendency to stay alone									
Yes	115	(24.6)	88	(23.0)	27	(31.8)	2.899	1	.096
No	353	(75.4)	295	(77.0)	58	(68.2)			
Tendency to laugh/cry alone									
Yes	91	(19.4)	64	(16.7)	27	(31.8)	10.065	1	**.002**
No	377	(80.6)	319	(83.3)	58	(68.2)			
Saying the same thing repeatedly									
Yes	91	(19.4)	68	(17.8)	23	(27.1)	3.845	1	.068
No	377	(80.6)	315	(82.2)	62	(72.9)			
Visual or auditory hallucinations									

(*continued on next page*)

Table 3 (*continued*)

Characteristics	Total $N = 468$		Self-reported		Family-reported		χ^2	*df*	*p*- value
	n	(%)	*n*	(%)	*n*	(%)			
Yes	109	(23.3)	85	(22.2)	24	(28.2)	1.421	1	.257
No	359	(76.7)	298	(77.8)	61	(71.8)			
Reserved or infuriated due to any irrational anxiety or fear									
Yes	114	(24.4)	295	(77.0)	26	(30.6)	2.187	1	.162
No	354	(75.6)	88	(23.0)	59	(69.4)			
Angry or destructive for no reason									
Yes	120	(25.6)	85	(22.2)	35	(41.2)	13.148	1	**.001**
No	348	(74.4)	298	(77.8)	50	(58.8)			
Tendency to harm/hit self or other									
Yes	81	(17.3)	60	(15.7)	21	(24.7)	3.972	1	.057
No	387	(82.7)	323	(84.3)	64	(75.3)			
Other concerns									
Face or physique seem different from others									
Yes	245	(52.4)	193	(50.4)	52	(61.2)	3.244	1	.073
No	223	(47.6)	190	(49.6)	33	(38.8)			
Uncontrolled urination/bowel movements creating an uncomfortable situation									
Yes	92	(80.3)	65	(17.0)	27	(31.8)	9.639	1	**.004**
No	376	(19.7)	318	(83.0)	58	(68.2)			
Trouble in sleeping									
Yes	68	(14.5)	53	(13.8)	15	(17.6)	0.813	1	.395
No	400	(85.5)	330	(86.2)	70	(82.4)			

Bold indicates statistical significance.

However, very few subjects reported sleeping-related (around 15%) and uncontrolled urination problems (around 20%), with the latter exhibiting significant age-related differences ($p = 0.04$).

When we compared whether the self-reported vs. family-reported responses to the disability-related symptoms were systematically different, we found significant differences in response to seven items (Table 3). The symptoms were – "Difficulty or delay in understanding verbal speeches" ($p = .004$), "Difficulty to express own thoughts in words or behavior" ($p = .000$), "Difficulty to play a fancy game with a toy or other things" ($p = .005$) under learning-associated concerns; "Making eye contact" ($p = .022$), "Tendency to laugh/cry alone" ($p = .002$), "Angry or destructive for no reason" ($p = .001$) among psychotic or behavioral-related matters; and "Uncontrolled urination/bowel movements" ($p = .004$) among other concerns. The most striking difference in response between self-reported vs. family-reported groups was observed in the case of having difficulty making eye contact. Compared to the majority (56.5%) of family members who responded about their family member with DS having this issue, the majority of the participants (57.7%) denied having this difficulty (Table 3).

3.3. Learning-related problems and severity of Down Syndrome

Associations between the severity of DS and disability-related items are shown in Table 4. Statistical significance was reached only in the items "difficulty in understanding or learning" ($p = 0.05$), "difficulty to express own thoughts in words or behavior" ($p = 0.03$), and "difficulty to play a fancy game with a toy or other things" ($p = 0.05$), as well as regarding "uncontrolled urination/bowel movements" ($p = 0.01$).

4. Discussion

This is the first detailed survey-based assessment on life-related issues among the Bangladeshi population with DS. From this large in-person survey, it becomes apparent that most of the subjects with DS have learning-related problems irrespective of age and gender, and that these challenges are significantly associated with the severity of DS. Considering the estimated number of individuals with DS in Bangladesh, these findings should provide valuable information regarding initiative aimed at their care and social inclusion, while enabling policymakers to design strategies targeting a more inclusive education and job training toward incorporation into the workforce.

The demographic analysis of this study revealed that most of the patients with DS were illiterate (>80%) (Table 1). Nearly 63% of the adult responders had no job or steady income, with more females being affected. Moreover, almost 85% of the individuals surveyed resided in rural areas. Our findings regarding DS severity concur with an earlier study conducted by Määttä et al. who showed the frequency of mild, moderate, and severe DS subjects in Finland were 19%, 30%, and 33%, respectively [22], but slightly different from the study of Nærland et al. who showed the proportions in Norway to be 25%, 56%, and 21%, respectively [11]. Furthermore, our study found a negligible difference in the degree of disability among the three age groups or in gender distribution. Our study was also consistent with the findings of Määttä and collaborator regarding difficulty in walking or any other movements which were less prevalent among adolescents [22].

Similar to an earlier study, our study also identified significant differences in verbal and non-verbal communicative skills among the different age groups [23]. The delays in learning or understanding verbal speech among children with DS can be attributable to a variety of factors which may also include age-related differences. However, our study did not find any gender-related differences in verbal and non-verbal communication among the DS subjects. When compared with the severity of DS symptoms, we found that subjects with severe DS symptoms had a 1.5 fold higher probability of facing difficulties in understanding or learning and a 1.5 fold higher likelihood of having difficulty expressing thoughts in words or behaviors than the DS subjects with mild to moderate symptoms. These findings were in contrast with a previous study that showed that 67.5% of the adults with DS could express themselves through basic oral language [24]. However, this study, conducted by Breia et al., examined only adult subjects, whereas the majority of our study subjects were <20 years of age (71.1%), which may account for the discrepant findings.

Table 4. Association of severity of Down Syndrome in subjects with gender, age, and disability-related symptoms.

	Severity of DS			
	Mild to Moderate (n = 295)	Severe (n = 173)	ORs (95% CI)	p
Gender				
Male (n = 263)	166 (63.1%)	97 (36.9%)	1.01 (0.69–1.47)	0.97
Female (n = 205)	129 (62.9%)	76 (37.1%)		
Age				
01–09 years (n = 151)	96 (63.6%)	55 (36.4%)		0.87
10–19 years (n = 182)	114 (62.6%)	68 (37.4%)		
≥20 years (n = 135)	85 (63.0%)	50 (37.0%)		
Ophthalmologic and auditory related				
Eyesight problems	11.2%	13.3%	1.21 (0.69–2.15)	0.49
Eyesight problems during day or night compared to others	10.5%	13.9%	1.37 (0.78–2.42)	0.28
Hearing problems	16.6%	20.2%	1.27 (0.78–2.06)	0.32
Motor skills-related				
Difficulty in walking or any other movements	44.4%	46.8%	1.10 (0.75–0.88)	0.61
Difficulties in self-cleaning or wearing clothes	46.4%	55.5%	1.44 (0.98–2.09)	0.06
Feeling of weakness/stiffness in hands and legs during walking or moving hands	43.4%	46.2%	1.12 (0.77–1.64)	0.55
Difficulty in standing, sitting, bending, lifting, any other movement, or walking compared to others	43.4%	45.7%	1.09 (0.75–1.59)	0.63
Repetitive action (e.g., continuously moving hands, shaking head)	12.9%	16.2%	1.31 (0.77–2.22)	0.32
Tendency of being blackout/faint or stiff, or having epilepsy	4.7%	6.9%	1.50 (0.67–3.31)	0.32
Learning related				
Difficulty in understanding/learning than others of the same age	62.4%	72.3%	1.57 (1.04–2.36)	**0.03**
Difficulty or delay in understanding verbal speeches	62.4%	69.4%	1.36 (0.92–2.04)	0.12
Difficulty to express own thoughts in words or behavior	60.3%	69.4%	1.49 (0.99–2.22)	**0.05**
Difficulty to play a fancy game with a toy or other things	21.4%	29.5%	1.53 (1.00–2.37)	**0.05**
Psychotic or behavioral-related				
Difficulty in making eye contact	43.1%	48%	0.82 (0.56–1.19)	0.30
Tendency to stay alone	22%	28.9%	1.43 (0.94–2.20)	0.96
Tendency to laugh/cry alone	17.6%	22.5%	1.36 (0.85–2.17)	0.19
Saying the same thing repeatedly	18.3%	21.4%	1.21 (0.76–1.94)	0.42
Visual or auditory hallucinations	22%	25.4%	1.20 (0.78–1.87)	0.40
Reserved or infuriated due to any irrational anxiety or fear	23.4%	26%	1.15 (0.74–1.77)	0.52
Angry or destructive for no reason	24.4%	27.7%	1.19 (0.77–1.82)	0.43
Tendency to harm/hit self or other	16.3%	19.1%	1.21 (0.74–1.97)	0.44
Other concerns				
Face or physique seem different from others	51.2%	54.3%	1.14 (0.78–1.65)	0.51
Uncontrolled urination/bowel movements creating an uncomfortable situation	15.9%	26%	1.85 (1.17–2.94)	**0.01**
Trouble in sleeping	13.2%	16.8%	1.32 (0.78–2.22)	0.29

Bold indicates statistical significance.

About 70% of the DS subjects are reported to experience eye issues, including refractive errors and visual diseases, which were significantly more common in the older participants (67%) compared to younger participants (50%) [9]. However, such issues were remarkably less frequent in our study irrespective of age. Previous studies further reported that 22%–78% of participants with DS as having conductive hearing loss [25, 26, 27, 28], but we observed no significant associations between either eyesight or hearing impairments with the severity of DS [29].

Frank and Esbensen (2015) developed fine motor and self-care milestone markers for children with DS [30]. Another study assessed specific age-related mastery of 44 gross motor skills in children with DS, where no statistically significant difference in mean age at gross motor skill achievement was observed between male and female children [31]. Similarly, although we observed age-specific significant differences in motor skills-related symptoms in individuals with DS (51.7% of children vs. 37.9% of adolescents having difficulty in walking or any other movements), we observed no significant gender-specific differences in motor skills (Table 2).

It is well-known that the prevalence of epilepsy and seizures increase with age, especially if there is any other comorbid condition, such as dementia or thyroid dysfunction [32], as well as the age of onset [33]. However, 3.3% of children, 7.7% of adolescents, and 5.2% of adults reported being affected with seizures. In contrast, a previous study conducted in Finland reported fainting and acute loss or disturbance of consciousness as affecting 18% and 45% of the participants, respectively

[9]. Almost half (47.4%) of a DS cohort in Portugal (n = 205) were found to have co-occurring conditions, including psychiatric disorders (72.0%) and epilepsy (8.5%) [24]. Some other previous studies identified seizures in 28% of the patients with DS living in Newcastle, UK [18], and epilepsy in 2% of DS children and adolescents in Hong Kong [6], while 21% of the aging adults were reported to experience seizures in Finland [9], and 4% of those living in Israel [32].

In the present study, all psychotic or behaviorally-related issues appeared to be more common in female DS subjects (Table 2). This finding contrasts with previous studies in which severe behavioral problems were significantly more likely to be found among Finnish males [22], or in Norwegian boys who tended to manifest more repetitive behaviors (37%), communication problems (33%), and social issues (34%) when compared to girls [11]. However, and consistent with the study from Norway [11], we also found no significant association between age and behavioral or emotional problems or the severity of autistic symptomatology. These findings are in contradiction with a previous study [22], which reported a correlation of the severity of ID with language impairments and age, and behavioral problems after adjustment for confounders. In contrast to the previous study that reported problematic externalizing behaviors (i.e., aggression, property destruction) among 19.6% of the adolescents (n = 46, age: 10–21 years) with DS without autism spectrum disorder, but no participants with self-injurious behavior [34], the tendency to harm/hit self or others fluctuated between 16-19% among our study participants, irrespective of gender and age.

In accordance with previous research [22], we observed no significant gender-based differences in mental health. However, we found age-related differences in mental health, since the tendency to stay alone or social withdrawal gradually increasing from 17.9% in children to 26.4% in adolescents and to 29.6% in adults. This finding also supported an earlier study that showed depression frequency was higher in adults with DS than in children and adolescents [22]. Furthermore, our analysis regarding the presence of unreasonable anxiety and fear among the DS male and female subjects (21.3% and 28.3%, respectively) corroborated a study in which no gender-based variation in the prevalence of anxiety among mentally disabled individuals was apparent [35].

Nearly 13.8% of people with DS aged <20 years in our study reported trouble sleeping - similar to the 9% of children and adolescents with DS in Hong Kong [6]. Nevertheless, approximately 30–57% of children with DS were reported to have symptoms and polysomnographically- confirmed obstructive sleep apnoea (OSA) syndrome [36, 37, 38]. Moreover, parents of children with DS reported inadequate and restless sleep among children with DS (n = 30, age: 6–17 years) correlating with their daytime behaviors in another study [39] - a scenario that is more likely to reflect the actual prevalence of sleep disorders among DS patients [40, 41, 42, 43].

The major strength of our study was the large cohort size that enabled representation of all regions of Bangladesh. However, there were several limitations. For example, many of the variables, including sociodemographic and disability symptoms, were self-reported. Because of the lack of any universal set measures being evaluated for all patients with DS, only a standard questionnaire formulated by disability experts was utilized in this study. Thus, we could not necessarily corroborate whether the disabilities reported and their severity. Moreover, as the data were only cross-sectional rather than longitudinal, patterns of change over time could not be assessed. Some previous studies examined a variety of reading skills and basic subskills of word recognition among students with ID and compared those with typically developing students of similar verbal ability level, underscoring the need for more attention to reading skills in children with ID, particularly those with DS [44]. However, as 87.18% of our study subjects reported of having no literacy, we did not test whether age and gender-specific differences in ability of learning to read exist among individuals with DS.

In summary, this study provides important information about age and gender-related behavioral disabilities in DS patients from Bangladesh. Consistent with extant evidence, our study demonstrates that learning-related disability is significantly associated with the severity of DS patients in Bangladesh which could assist in earlier capture of the behavioral problems in DS patients and differentiating them from other disabilities. Thus, systematic assessment of learning-related disability may help implementation of social, educational, and healthcare supportive measures, such as music therapy, which has been found effective for children with DS to develop memory, learning, speech and language skills, social and communication skills; as well as motor, movement, and coordination skills [45]. Overall, our findings should enable better tailoring of evaluation and interventions directed at different age groups. Country-level initiatives aimed at economic, healthcare, and educational infrastructures should be tailored for individuals with DS in Bangladesh, with particular attention to women, those unemployed, and those who reside in rural areas, who seem to be at a disadvantage in their ability to access assistance and support systems.

Declarations

Author contribution statement

Nafisa Nawal Islam: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Ahmed Faisal Sumit: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Md. Mottakin Chowdhury, Yusha Araf and Bishajit Sarkat: Contributed reagents, materials, analysis tools or data.

Md. Asad Ullah and David Gozal: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data included in article/supplementary material/referenced in article.

Declaration of interests statement

The authors declare no conflict of interest.

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