Original Paper

Understanding Characteristics of Autism Spectrum Disorder Using ICF-CY

Fumiaki MIKAMI[*1], **Hisashi MIYAZAKI**[*2], **Momoka IWADO**[*3],
Sanae ODAGIRI[*4], **Masako MORITO**[*5], **Tomoko NANBA**[*6] and
Yuko TAKEI[*7]

Abstract

Announced by the World Health Organization, the International Classification of Functioning, Disability and Health for Children & Youth Version (ICF-CY) is a tool that enables the recording of children's health and functioning. The purpose of this study was to classify the functioning of children with autism spectrum disorder (ASD) by using the ICF-CY in order to understand the characteristics of children with ASD. ICF-CY coding subjects were 14-, 12-, 11-, 6-, and 10-year-old males (study subjects referred to as Case A, B, C, D, and E, respectively) who had been diagnosed with ASD. Their mothers were interviewed regarding the children's characteristics, and audio recordings of the interviews were retained (the records of the five mothers interviewed produced a total of 152,870 Japanese characters). A frequency distribution table was created from the number of characteristics under these classification codes, and the characteristics of the children with ASD were graphed in a histogram. The three most common categories (items) were e410 (Individual attitudes of immediate family members) with 233 characteristics, d250 (Managing one's own behavior) with 165 characteristics, and b156 (Perceptual functions) with 147 characteristics. Results of the cluster analysis showed that study subjects A and C had the most similar code count distributions. By using the ICF-CY and frequency distribution tables to express the functioning of children with ASD, we showed that it is possible to understand the range and strength of support that children with ASD need.

1. Introduction

The essential features of autism spectrum disorder (ASD) are persistent impairment in reciprocal social communication and social interaction, and restricted, repetitive patterns of behavior, interests, or activities[1].

[*1] Department of Health Informatics, Faculty of Health and Welfare Services Administration,
    Kawasaki University of Medical Welfare, Kurashiki, 701-0193, Japan
    E-Mail: `fmikami@mw.kawasaki-m.ac.jp`
[*2] Department of Medical Engineering, Faculty of Health Science and Technology, Kawasaki University of Medical Welfare
[*3] Department of Design for Medical and Health Care, Faculty of Health and Welfare Services Administration,
    Kawasaki University of Medical Welfare
[*4] Department of Social Work, Faculty of Health and Welfare, Kawasaki University of Medical Welfare
[*5] Department of Nursing, Faculty of Health and Welfare, Kawasaki University of Medical Welfare
[*6] Department of Health and Sports Science, Faculty of Health Science and Technology, Kawasaki University of Medical Welfare
[*7] Department of Clinical Psychology, Faculty of Health and Welfare, Kawasaki University of Medical Welfare

These symptoms are present from early childhood and limit or impair everyday functioning. In Japan, many children with ASD live with their families out in the community. As with neurotypical children, they go to preschools, kindergartens, schools, hospitals, and such as they grow, and they have relationships with many professionals as needed. For that reason, there are many opportunities for the families of children with ASD to document and provide information in a variety of forms so that the staff at the relevant institutions can understand the characteristics of each child who has a disorder[2]. However, the vast amount of submitted information is often not shared between the relevant organizations, and is often not even shared satisfactorily between the staff members at the same institution[3,4]. ASD is called an "invisible disability". Having others understand a child's sensory characteristics (such as hyperesthesia and hypoesthesia) can be particularly challenging, and it has been pointed out that families struggle over this issue[5]. Even when there is no issue at home in the environment provided by the family, a variety of difficulties can be encountered in social life.

In 2001, the World Health Organization (WHO) announced an International Classification of Functioning, Disability and Health (ICF)[6], a tool for describing disability and illness conditions and promoting common understanding. One of the purposes of the ICF is "to establish a common language for describing health and health-related states in order to improve communication between different users, such as health care workers, researchers, policy-makers and the public, including people with disabilities". The ICF organizes information in two parts: [Functioning], which includes "Body functions", "Activities", and "Participation"; and their interactions with "Environmental factors". That is, [Functioning] is a generic term that includes everything related to "Body functions and structures", "Activities", and "Participation", and these Components are interconnected (Figure 1). When there is difficulty with "Body functions and
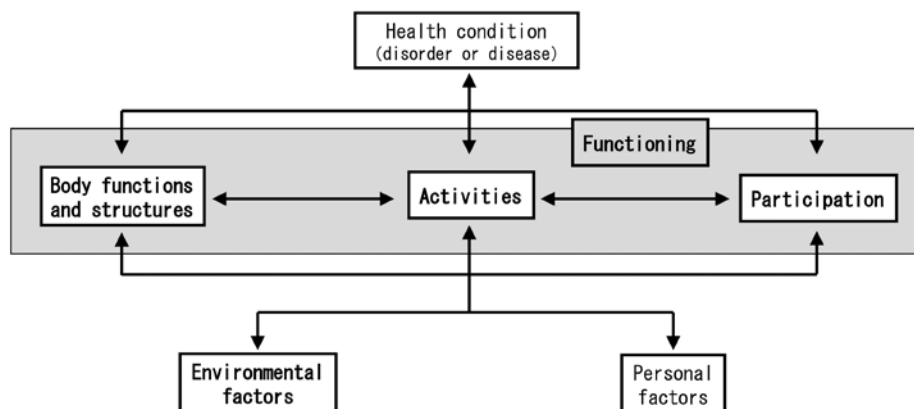

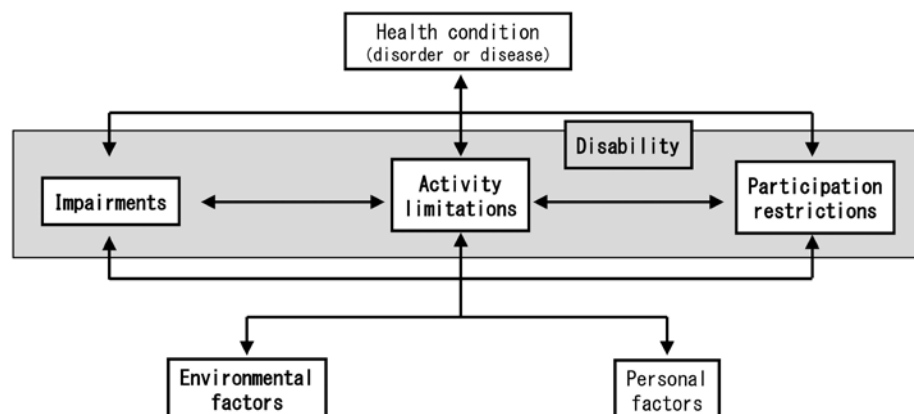Figure 1   Interactions between the components of ICF (functioning)

Figure 2   Interactions between the components of ICF (disability)

Table 1   Definitions of ICF components

In the context of health:

Body functions are the physiological functions of body systems (including psychological functions).

Body structures are anatomical parts of the body such as organs, limbs and their components.

Impairments are problems in body function or structure such as a significant deviation or loss.

Activity is the execution of a task or action by an individual.

Participation is involvement in a life situation.

Activity limitations are difficulties an individual may have in executing activities.

Participation restrictions are problems an individual may experience in involvement in life situations.

Environmental factors make up the physical, social and attitudinal environment in which people live and conduct their lives.

---

structures", "Activities", or "Participation", these conditions are therein termed [Disability], a generic term that includes everything related to "Impairments", "Activity limitations", and "Participation restrictions" (Figure 2). Environmental factors interact with all of the aforementioned Components. Definitions of these Components[6] are provided in Table 1.

The ICF provides classification of these Components at four levels of detail, from broad to detailed (fourth level), with the Components differentiated by the initial letter of the classification code. For example, b110 (Consciousness functions) is under Body functions; s110 (Structure of brain), Body structure; a110 (Watching), Activities; p920 (Recreation and leisure), Participation; and e110 (Products or substances for personal consumption), Environmental factors. However, since Activities (s) and Participation (p) include behaviors or actions that could be classified as either an activity or participation item, depending on the situation or condition, differentiation can be difficult and some classification items are thus completely the same. When classifying without particularly differentiating between an activity or participation item, a "d" is attached as the initial letter, such as in d110. Incidentally, along with Environmental factors in the ICF, Personal factors are considered as important as Contextual factors, but since there are large differences socially and culturally between individuals, the ICF does not provide a classification. One major feature of the ICF is that an "Environmental factors" perspective was added to evaluations, based on the concept that a person who lives in an environment where advanced "barrier-free" improvements have been made will have higher levels of activity and participation compared to a person with the same level of impairment who does not live in such an environment. Although the ICF incorporated new perspectives such as this when created, a noted shortcoming is that it may not sufficiently cover the rapid growth and changes that occur in a person's first 20 years of life. Therefore, in order to supplement the ICF and take into consideration functioning-related characteristics in the childhood and adolescent period, the WHO developed the International Classification of Functioning, Disability and Health for Children & Youth Version (ICF-CY) and publicly released it in 2007[7]. Since the ICF-CY is a derived version of the main ICF, it is consistent with the main ICF and contains the same classification structure and categories. The main ICF is a comprehensive volume, while the ICF-CY provides supplementary detailed content necessary for recording characteristics during children's growth and development periods. Accordingly, it is used to record children's health and functioning characteristics, and is also similar to the ICF in that it can be utilized by clinicians, educators, policymakers, families, children in question, and researchers to share information.

Using the conventional ICF, the authors have already examined the current status of functioning and disabilities of an orthopedically impaired female university student[8], children in institutions for orthopedic impairments[9-11], and children in special-needs schools (for intellectual disabilities)[12,13], and have shown the effectiveness of the ICF. Although there are many scales for evaluating functioning and disabilities,

the authors confirmed that by reclassifying these scales' evaluation items using the ICF and statistically processing them, it is possible to gain an understanding of the characteristics and similarities of the respective scales[14].

The purpose of this study was to use the ICF-CY to describe characteristics of children with ASD that were difficult to grasp and understand, even by their families, and thus to understand individual characteristics and promote the sharing of information on the care they need.

2. Methods

2.1 Participants

We recruited the study subjects by distributing research participant invitation leaflets to the families of ASD children via nonprofit organizations and public agencies used by ASD children, such as developmental disability support centers and the Autism Society in residential areas. Chosen as analysis subjects for this study were five mothers of boys between the ages of 6 and 14 who had received a diagnosis corresponding to ASD. The mothers had shown a willingness to participate and agreed to cooperate in the study (Table 2).

Table 2   Summary of cases

	Case A	Case B	Case C	Case D	Case E
Age	14	12	11	6	10
Sex	Male	Male	Male	Male	Male
Age when diagnosed	4	3	Under 3	2	3

2.2 Study methods and content

During a period from September to December, 2014, semistructured interviews were conducted with the mothers of the subject children. The mothers were asked the child's age, sex, diagnostic name, age when diagnosed, difficulties related to the child's sensory characteristics from infancy to childhood, and the family's response (coping strategy) and thoughts. The interviews were conducted by a two-person team, with one researcher primarily interviewing the mother, while the other researcher was responsible for making written and audio records. A single interview lasted about 60 minutes. When necessary, one or two follow-up interviews were conducted.

2.3 Data analysis methods

Keywords from the voice records of the five mothers' interviews were classified at the second level of the ICF-CY codes. The classification work was performed by the study's senior researcher, who was very knowledgeable about the ICF system. In this study, "Activities" and "Participation" were not differentiated. Instead, a "d" code was used for "Activities and participation". For example, the characteristic "Has issues with group behavior" is classified under "d720 Complex interpersonal interactions" in the ICF-CY system. A frequency distribution table was created from the number of characteristics under these classification codes, and the characteristics of the children with ASD were graphed in a histogram. Furthermore, in order to examine the similarity in the characteristics of the five ASD children, we performed a cluster analysis, using the frequency distribution table that had been created. StatFlex 6.0 was used for the statistical software.

2.4 Ethical considerations

The researchers again met with the families who had expressed a willingness to participate in the study. The researchers explained the request for research cooperation/participation, and had the participating families sign and seal a consent form. At the same time, the researchers distributed a consent withdrawal

form and return envelope, and explained that the participants could withdraw from the study even after agreeing, and that no unfavorable or injurious actions would be taken if they withdrew. Also, other issues, including steps that would be taken to alleviate worries expressed during the interview, protection of the subjects' personal information, and methods used to destroy/dispose of data, were discussed and agreed upon. Incidentally, this study was conducted with the approval of the Ethics Committee of the Kawasaki University of Medical Welfare.

3. Results

The transcribed voice records of the five mothers' interviews contained a total of 152,870 Japanese characters. From these records, 2,096 episodes (characteristics) were classified into 123 ICF-CY codes (Table 3).

Table 3   Transcribed voice records and ICF-CY characteristics for each case

	Case A	Case B	Case C	Case D	Case E	Total
Japanese characters from voice record	38,144	31,141	27,694	23,252	32,639	152,870
Keywords classified with ICF-CY	714	389	425	189	379	2,096

3.1 Number of characteristics by component

At the Component level, there were some variations between individuals; however, characteristics were classified into Body Functions, Activities and Participation, and Environmental Factors without large deviation (21.7% - 49.9%). Overall, Body functions made up the largest percentage (37.4%), followed by Environmental factors (32.8%) and Activities and participation (29.8%), as shown in Table 4.

Table 4   Number of characteristics by ICF-CY component (%)

	Case A	Case B	Case C	Case D	Case E	Total
Body function	278 (38.9%)	100 (25.7%)	212 (49.9%)	82 (43.4%)	112 (29.6%)	784 (37.4%)
Activity and participation	212 (29.7%)	149 (38.3%)	112 (26.4%)	41 (21.7%)	110 (29.0%)	624 (29.8%)
Environment	224 (31.4%)	140 (36.0%)	101 (23.8%)	66 (34.9%)	157 (41.4%)	688 (32.8%)
Total	714	389	425	189	379	2,096

3.2 Number of body function characteristics

Codes and number of characteristics classified under Body functions are shown in Table 5. Numerals in brackets [ ] indicate the individual's ranking compared to the others, based on number of characteristics. Based on total characteristics classified for the five participants, the Top 3 in number were b156 (Perceptual functions) with 147 characteristics (number of characteristics and ranking by individual: A: 71 [1], B: 9 [4], C: 47 [1], D:10 [3], E: 10 [4]), b164 (Higher-level cognitive functions) with 98 (A: 23 [4], B: 25 [1], C: 24 [2], D: 11 [2], E: 15 [2]), and b152 (Emotional functions) with 78 (A: 28 [3], B: 8 [5], C: 15 [3], D: 2 [9], E: 25 [1]).

3.3 Number of activities and participation characteristics

Codes and number of characteristics classified under Activities and participation are shown in Table 6. Numerals in brackets [ ] indicate the individual's ranking compared to the others, based on number of

Table 5   Characteristics classified under Body functions (two-level classification) and ranking

	Case A	Case B	Case C	Case D	Case E	Total
b114 Orientation functions	0 [21]	0 [17]	1 [22]	0 [22]	2 [15]	3 [23]
b117 Intellectual functions	0 [21]	0 [17]	1 [22]	1 [17]	0 [19]	2 [25]
b125 Dispositions and intra-personal functions	0 [21]	12 [3]	4 [16]	3 [7]	8 [5]	27 [9]
b126 Temperament and personality functions	0 [21]	0 [17]	1 [22]	0 [22]	2 [15]	3 [23]
b130 Energy and drive functions	9 [10]	7 [6]	7 [9]	10 [3]	3 [10]	36 [6]
b134 Sleep functions	0 [21]	0 [17]	1 [22]	1 [17]	0 [19]	2 [25]
b140 Attention functions	1 [17]	0 [17]	4 [16]	2 [9]	3 [10]	10 [17]
b144 Memory functions	13 [8]	4 [8]	5 [13]	3 [7]	3 [10]	28 [8]
b147 Psychomotor functions	6 [11]	3 [11]	5 [13]	2 [9]	4 [7]	20 [12]
b152 Emotional functions	28 [3]	8 [5]	15 [3]	2 [9]	25 [1]	78 [3]
b156 Perceptual functions	71 [1]	9 [4]	47 [1]	10 [3]	10 [4]	147 [1]
b160 Thought functions	0 [21]	0 [17]	2 [19]	0 [22]	2 [15]	4 [21]
b163 Basic cognitive functions	21 [5]	13 [2]	15 [3]	14 [1]	14 [3]	77 [4]
b164 Higher-level cognitive functions	23 [4]	25 [1]	24 [2]	11 [2]	15 [2]	98 [2]
b167 Mental functions of language	0 [21]	4 [8]	7 [9]	2 [9]	4 [7]	17 [13]
b210 Seeing functions	5 [12]	1 [12]	10 [6]	0 [22]	0 [19]	16 [14]
b230 Hearing functions	39 [2]	6 [7]	15 [3]	5 [5]	4 [7]	69 [5]
b235 Vestibular functions	2 [15]	0 [17]	0 [30]	0 [22]	0 [19]	2 [25]
b250 Taste function	0 [21]	0 [17]	5 [13]	2 [9]	0 [19]	7 [19]
b255 Smell function	18 [6]	1 [12]	6 [12]	1 [17]	5 [6]	31 [7]
b260 Proprioceptive function	4 [14]	1 [12]	1 [22]	2 [9]	0 [19]	8 [18]
b265 Touch function	11 [9]	1 [12]	10 [6]	2 [9]	3 [10]	27 [9]
b270 Sensory functions related to temperature and other stimuli	5 [12]	0 [17]	7 [9]	1 [17]	3 [10]	16 [14]
b280 Sensation of pain	0 [21]	0 [17]	3 [18]	0 [22]	2 [15]	5 [20]
b430 Haematological system functions	0 [21]	0 [17]	1 [22]	0 [22]	0 [19]	1 [29]
b510 Ingestion functions	17 [7]	0 [17]	9 [8]	0 [22]	0 [19]	26 [11]
b530 Weight maintenance functions	0 [21]	0 [17]	1 [22]	0 [22]	0 [19]	1 [29]
b550 Thermoregulatory functions	0 [21]	1 [12]	0 [30]	0 [22]	0 [19]	1 [29]
b640 Sexual functions	0 [21]	0 [17]	1 [22]	0 [22]	0 [19]	1 [29]
b730 Muscle power functions	1 [17]	0 [17]	0 [30]	1 [17]	0 [19]	2 [25]
b735 Muscle tone functions	1 [17]	0 [17]	0 [30]	0 [22]	0 [19]	1 [29]
b755 Involuntary movement reaction functions	1 [17]	0 [17]	0 [30]	0 [22]	0 [19]	1 [29]
b760 Control of voluntary movement functions	2 [15]	4 [8]	2 [19]	5 [5]	0 [19]	13 [16]
b765 Involuntary movement functions	0 [21]	0 [17]	2 [19]	2 [9]	0 [19]	4 [21]
Total	278	100	212	82	112	784

Table 6 Characteristics classified under Activities and Participation (two-level classification) and ranking

	Case A	Case B	Case C	Case D	Case E	Total
d110 Watching	0 [35]	0 [32]	2 [13]	0 [11]	0 [29]	2 [33]
d115 Listening	3 [15]	0 [32]	0 [27]	0 [11]	0 [29]	3 [29]
d120 Other purposeful sensing	1 [25]	1 [19]	0 [27]	0 [11]	0 [29]	2 [33]
d130 Copying	0 [35]	0 [32]	0 [27]	0 [11]	1 [18]	1 [41]
d132 Acquiring information	16 [4]	3 [11]	0 [27]	0 [11]	1 [18]	20 [8]
d133 Acquiring language	0 [35]	0 [32]	0 [27]	0 [11]	1 [18]	1 [41]
d135 Rehearsing	1 [25]	0 [32]	0 [27]	0 [11]	0 [29]	1 [41]
d137 Acquiring concepts	4 [12]	3 [11]	2 [13]	0 [11]	0 [29]	9 [15]
d140 Learning to read	0 [35]	1 [19]	3 [8]	0 [11]	1 [18]	5 [22]
d145 Learning to write	0 [35]	4 [9]	3 [8]	1 [9]	7 [7]	15 [9]
d155 Acquiring skills	1 [25]	5 [7]	0 [27]	0 [11]	1 [18]	7 [18]
d160 Focusing attention	5 [7]	1 [19]	1 [19]	0 [11]	1 [18]	8 [17]
d161 Directing attention	1 [25]	0 [32]	0 [27]	0 [11]	0 [29]	1 [41]
d163 Thinking	0 [35]	1 [19]	0 [27]	0 [11]	1 [18]	2 [33]
d166 Reading	3 [15]	0 [32]	0 [27]	0 [11]	1 [18]	4 [25]
d170 Writing	0 [35]	1 [19]	2 [13]	0 [11]	3 [9]	6 [20]
d177 Making decisions	3 [15]	6 [5]	2 [13]	0 [11]	1 [18]	12 [13]
d230 Carrying out daily routine	5 [7]	5 [7]	1 [19]	0 [11]	2 [12]	13 [10]
d240 Handling stress and other psychological demands	17 [3]	6 [5]	8 [3]	3 [4]	10 [4]	44 [4]
d250 Managing one's own behaviour	62 [1]	50 [1]	27 [1]	14 [1]	12 [2]	165 [1]
d310 Communicating with - receiving - spoken messages	5 [7]	3 [11]	3 [8]	2 [7]	0 [29]	13 [10]
d315 Communicating with - receiving - nonverbal messages	3 [15]	3 [11]	1 [19]	0 [11]	0 [29]	7 [18]
d325 Communicating with - receiving - written messages	0 [35]	2 [16]	0 [27]	0 [11]	0 [29]	2 [33]
d330 Speaking	16 [4]	10 [4]	7 [5]	2 [7]	6 [8]	41 [5]
d331 Pre-talking	0 [35]	0 [32]	1 [19]	0 [11]	0 [29]	1 [41]
d332 Singing	2 [22]	0 [32]	0 [27]	0 [11]	0 [29]	2 [33]
d335 Producing nonverbal messages	0 [35]	0 [32]	1 [19]	0 [11]	0 [29]	1 [41]
d350 Conversation	1 [25]	0 [32]	0 [27]	0 [11]	0 [29]	1 [41]
d360 Using communication devices and techniques	0 [35]	1 [19]	0 [27]	0 [11]	0 [29]	1 [41]
d415 Maintaining a body position	1 [25]	0 [32]	0 [27]	0 [11]	0 [29]	1 [41]
d440 Fine hand use	0 [35]	1 [19]	0 [27]	0 [11]	2 [12]	3 [29]
d445 Hand and arm use	0 [35]	1 [19]	0 [27]	0 [11]	0 [29]	1 [41]
d450 Walking	1 [25]	0 [32]	0 [27]	0 [11]	0 [29]	1 [41]
d470 Using transportation	1 [25]	1 [19]	3 [8]	0 [11]	0 [29]	5 [22]
d510 Washing oneself	0 [35]	0 [32]	3 [8]	0 [11]	0 [29]	3 [29]
d520 Caring for body parts	0 [35]	0 [32]	2 [13]	0 [11]	0 [29]	2 [33]
d540 Dressing	0 [35]	3 [11]	1 [19]	0 [11]	0 [29]	4 [25]
d550 Eating	4 [12]	1 [19]	17 [2]	4 [3]	8 [6]	34 [6]
d560 Drinking	0 [35]	0 [32]	0 [27]	0 [11]	2 [12]	2 [33]
d570 Looking after one's health	0 [35]	2 [16]	0 [27]	0 [11]	1 [18]	3 [29]
d571 Looking after one's safety	3 [15]	0 [32]	0 [27]	0 [11]	3 [9]	6 [20]
d710 Basic interpersonal interactions	5 [7]	1 [19]	0 [27]	1 [9]	3 [9]	10 [14]
d720 Complex interpersonal interactions	2 [22]	2 [16]	0 [27]	0 [11]	0 [29]	4 [25]
d730 Relating with strangers	1 [25]	0 [32]	1 [19]	0 [11]	0 [29]	2 [33]
d750 Informal social relationships	3 [15]	0 [32]	0 [27]	0 [11]	1 [18]	4 [25]
d760 Family relationships	7 [6]	11 [3]	8 [3]	8 [2]	14 [1]	48 [2]
d815 Preschool education	4 [12]	4 [9]	1 [19]	3 [4]	12 [2]	24 [7]
d816 Preschool life and related activities	3 [15]	0 [32]	0 [27]	0 [11]	2 [12]	5 [22]
d820 School education	20 [2]	14 [2]	5 [6]	0 [11]	9 [5]	48 [2]
d830 Higher education	0 [35]	1 [19]	0 [27]	0 [11]	0 [29]	1 [41]
d880 Engagement in play	2 [22]	0 [32]	2 [13]	3 [4]	2 [12]	9 [15]
d910 Community life	1 [25]	0 [32]	0 [27]	0 [11]	0 [29]	1 [41]
d920 Recreation and leisure	5 [7]	1 [19]	5 [6]	0 [11]	2 [12]	13 [10]
Total	212	149	112	41	110	624

Table 7   Characteristics classified under Environmental factors (two-level classification) and ranking

	Case A	Case B	Case C	Case D	Case E	Total
e110 Products or substances for personal consumption	7 [10]	0 [22]	12 [2]	0 [12]	4 [5]	23 [8]
e115 Products and technology for personal use in daily living	5 [14]	1 [15]	10 [3]	0 [12]	1 [15]	17 [9]
e120 Products and technology for personal indoor and outdoor mobility and transportation	0 [27]	1 [15]	0 [20]	0 [12]	0 [23]	1 [26]
e125 Products and technology for communication	0 [27]	1 [15]	2 [9]	0 [12]	1 [15]	4 [22]
e130 Products and technology for education	0 [27]	0 [22]	0 [20]	0 [12]	3 [9]	3 [24]
e150 Design, construction and building products and technology of buildings for private use	3 [16]	2 [12]	1 [11]	0 [12]	0 [23]	6 [19]
e220 Flora and fauna	1 [20]	2 [12]	0 [20]	0 [12]	1 [15]	4 [22]
e230 Natural events	1 [20]	0 [22]	0 [20]	0 [12]	0 [23]	1 [26]
e235 Human-caused events	1 [20]	0 [22]	0 [20]	0 [12]	0 [23]	1 [26]
e240 Light	0 [27]	0 [22]	1 [11]	0 [12]	0 [23]	1 [26]
e250 Sound	28 [2]	4 [6]	9 [4]	2 [7]	4 [5]	47 [4]
e260 Air quality	8 [9]	0 [22]	0 [20]	0 [12]	4 [5]	12 [13]
e310 Immediate family	6 [12]	4 [6]	0 [20]	1 [8]	4 [5]	15 [12]
e315 Extended family	0 [27]	0 [22]	1 [11]	0 [12]	0 [23]	1 [26]
e320 Friends	3 [16]	0 [22]	1 [11]	1 [8]	1 [15]	6 [19]
e325 Acquaintances, peers colleagues, neighbours and community members	6 [12]	2 [12]	0 [20]	0 [12]	0 [23]	8 [15]
e330 People in positions of authority	0 [27]	0 [22]	0 [20]	0 [12]	1 [15]	1 [26]
e340 Personal care providers and personal assistants	0 [27]	0 [22]	1 [11]	0 [12]	0 [23]	1 [26]
e345 Strangers	1 [20]	1 [15]	0 [20]	0 [12]	0 [23]	2 [25]
e360 Other professionals	2 [18]	1 [15]	1 [11]	1 [8]	3 [9]	8 [15]
e410 Individual attitudes of immediate family members	45 [1]	53 [1]	41 [1]	27 [1]	67 [1]	233 [1]
e420 Individual attitudes of friends	9 [8]	4 [6]	0 [20]	0 [12]	3 [9]	16 [10]
e425 Individual attitudes of acquaintances, peers colleagues, neighbours and community members	12 [6]	10 [4]	0 [20]	0 [12]	10 [4]	32 [6]
e430 Individual attitudes of people in positions of authority	0 [27]	1 [15]	2 [9]	3 [6]	1 [15]	7 [17]
e445 Individual attitudes of strangers	7 [10]	0 [22]	0 [20]	0 [12]	0 [23]	7 [17]
e450 Individual attitudes of health professionals	18 [4]	3 [10]	3 [7]	11 [2]	1 [15]	36 [5]
e455 Individual attitudes of other professionals	18 [4]	20 [2]	3 [7]	6 [4]	22 [2]	69 [2]
e465 Social norms, practices and ideologies	1 [20]	7 [5]	1 [11]	0 [12]	2 [13]	11 [14]
e510 Services, systems and policies for the production of consumer goods	1 [20]	0 [22]	0 [20]	0 [12]	0 [23]	1 [26]
e535 Communication services, systems and policies	1 [20]	0 [22]	0 [20]	0 [12]	0 [23]	1 [26]
e540 Transportation services, systems and policies	0 [27]	1 [15]	0 [20]	0 [12]	0 [23]	1 [26]
e560 Media services, systems and policies	4 [15]	0 [22]	1 [11]	0 [12]	0 [23]	5 [21]
e570 Social security services, systems and policies	0 [27]	0 [22]	0 [20]	0 [12]	1 [15]	1 [26]
e575 General social support services, systems and policies	2 [18]	4 [6]	1 [11]	6 [4]	3 [9]	16 [10]
e580 Health services, systems and policies	11 [7]	3 [10]	5 [5]	7 [3]	2 [13]	28 [7]
e585 Education and training services, systems and policies	23 [3]	15 [3]	5 [5]	1 [8]	18 [3]	62 [3]
Total	224	140	101	66	157	688

characteristics. Based on total characteristics classified for the five participants, the Top 3 in number were d250 (Managing one's own behavior) with 165 characteristics (number of characteristics and ranking by individual: A: 62 [1], B: 50 [1], C: 27 [1], D: 14 [1], E: 12 [2]), d760 (Family relationships) with 48 (A: 7 [6], B: 11 [3], C: 8 [3], D: 8 [2], E: 14 [1]) and d820 (School education) with 48 (A: 20 [2], B: 14 [2], C: 5 [6], D: 0 [11], E: 9 [5]).

3.4 Number of environmental factors characteristics

Codes and number of characteristics classified under Environmental factors are shown in Table 7. Numerals in brackets [ ] indicate the individual's ranking compared to the others, based on number of characteristics. Based on total characteristics classified for the five participants, the Top 3 in number were e410 (Individual attitudes of immediate family members) with 233 characteristics (number of characteristics and ranking by individual: A: 45 [1], B: 53 [1], C: 41 [1], D: 27 [1], E: 67 [1]), e455 (Individual attitudes of other professionals) with 69 (A: 18 [4], B: 20 [2], C: 3 [7], D:6 [4], E: 22 [2]), and e585 (Education and training services, systems and policies) with 62 (A: 23 [3], B: 15 [3], C: 5 [5], D: 1 [8], E: 18 [3]).

3.5 Percentage of number of characteristics overall

The frequency distribution chart (histogram) in Figure 3 combines the frequency distribution tables shown in Tables 5 to 7. After creating tables showing the percentage of the number of second-level ICF-CY codes for all components, and then rearranging them in descending order based on the mean of characteristics for the five subjects, we graphed those codes that contained a mean of at least 0.5%.

The Top 3 were e410 (Individual attitudes of immediate family members), d250 (Managing one's own behavior), and, b156 (Perceptual functions) with each being No. 1 in number of characteristics by Component.

3.6 Distribution similarities

We performed a cluster analysis based on the data from the table that combined the frequency distribution tables shown in Tables 5 to 7. We confirmed that the distributions for study subjects A and C were the most similar (Figure 4).

4. Discussion

The mothers of the five subjects who had received a diagnosis corresponding to ASD were asked about difficulties related to their child's sensory characteristics and about the family's response and thoughts. The content was then classified using ICF-CY codes. Since questions related to sensory characteristics were being asked in this study, it is only natural that in the area of Body functions (Table 5), the largest number of episodes were classified as perceptual functions (b156), which include auditory perception (b1560), visual perception (b1561), and olfactory perception (b1562); however, it can be said that we confirmed the possibility of expressing those items using the ICF-CY. In the authors' opinion, a distinguishing feature of this recent study is that over 30% of the characteristics were classified as Environmental factors. In the authors' previous research, the ICF was used to classify evaluation items from evaluation tables used to understand a variety of disabilities. That gave us an outline of the evaluation content. However, hardly any Environmental factors-related items existed[14]. That may be because when specialists try to understand an individual's disability, they focus on Body functions when checking. There is insufficient focus on Environmental factors that promote or impede activities and participation (and thus greatly affect a child's quality of life). That ICF perspective is lacking in evaluation tables. During this study, the families have stated that it is more important for them to understand what a comfortable environment consists of and how to create one, rather than having detailed knowledge of the Body functions of children with ASD, a disability that the families think should not only be considered from the perspective of the illness and its treatment. We believe that such questions can be answered by using ICF-CY to express or describe a disability. Finally, the number of ICF-CY classifications for each of the children can also be thought of as
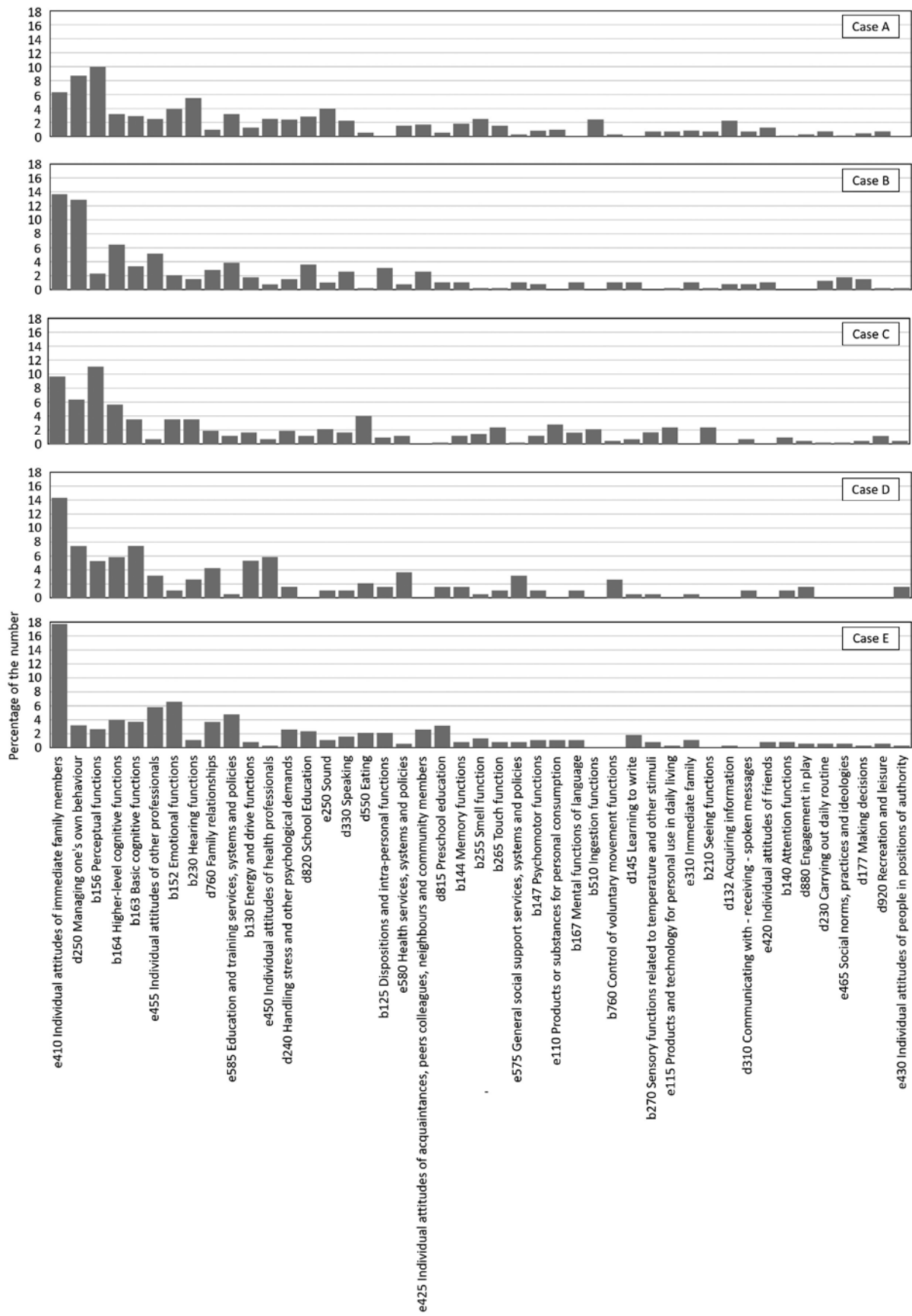
Figure 3   Second-level ICF-CY code count (those with at least 10 for five subjects combined)
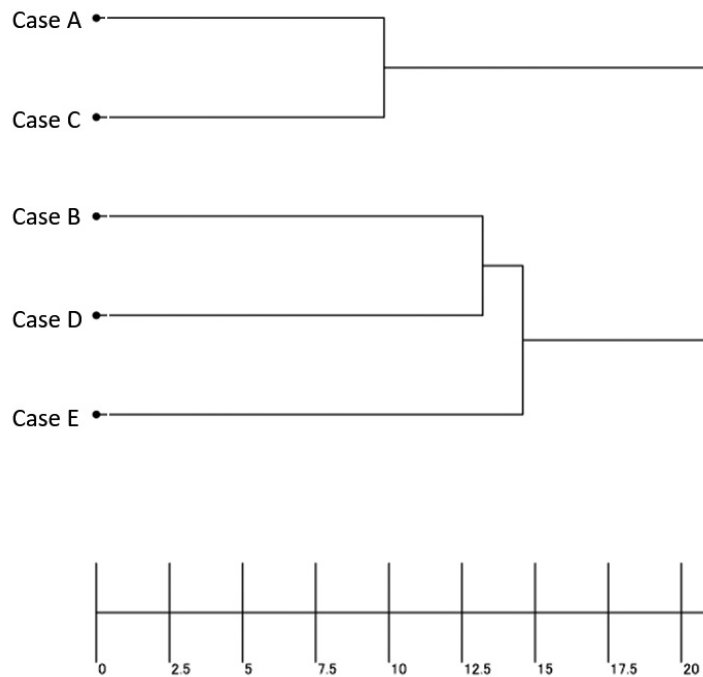
Figure 4   Similarity of distributions via cluster analysis

a spectrum that expresses or represents the children's characteristics. Looking at Fig. 3, one can't classify clearly that each case has similar distributions. However, when the similarities were classified using the statistical technique known as a cluster analysis, case A and C were again the most similar (Figure 4). And the difficulty of having many sensations (visual, auditory, vestibule, tactile and oral sensation) was reported about case A and C, which was considered to be reflected by the cluster analysis. We believe that it is possible to identify common types of necessary support and effective environments if a series of steps are taken, that is, if the content from interviews and records of children's characteristics is classified into ICF-CY codes, frequency distribution tables are created, and cluster analysis is utilized to identify similar children. Incidentally, at the present time, items are classified into ICF-CY codes through human brainwork, which requires much time and effort. The reliability of the classification can't be guaranteed because it was only classified by 1 researcher using this particular research. It is desirable to classify them by more than one person in order to improve the reliability and show the precision of the classification quality using the kappa statistic. If we combine machine learning and ICF-CY, however, that should enable us to easily and effectively identify the various spectrum characteristics.

5. Conclusions

By using the ICF-CY and frequency distribution tables to express the functioning of children with ASD, we can better understand the range of support and strength that ASD children need. Also, using a statistical technique such as cluster analysis to classify the histograms of each subject child should enable us to examine common types of support that will be needed by ASD children with similar characteristics. In the future, if we collect data on all persons who have difficulty functioning in their everyday lives and then analyze the data using the same techniques, that may help us understand the characteristics of various types of disabilities and identify common types of support that will be required.

References

 1. American Psychiatric Association : *Diagnostic and statistical manual of mental disorders*. 5th Edition, American Psychiatric Publishing, Arlington, 2013.
 2. Morito M, Mikami F, Miyazaki H, Iwado M, Odagiri S, Nanba T and Takei Y : A proposal for the development of ICT support tools for children with autism spectrum disorders. *Japanese Journal of Applied of IT Healthcare*, **11**(1), 147-150, 2016. (In Japanese with English abstract)
 3. Sasamori H, Gokami T, Kuboyama S, Kobayashi M, Hirose Y, Sawada M and Fujii S : Current situation and problems for early detection and early support for children with developmental disability. *Bulletin of the National Institute of Special Needs Education*, **37**, 3-15, 2010. (In Japanese with English abstract)
 4. Tanigawa K, Oomura K, Togari T and Harada N : Cooperation in health, medicine, welfare and education for children with autism in nursery school and kindergarten. *Journal of the National Institute of Public Health*, **58**(2), 141-153, 2009. (In Japanese with English abstract)
 5. Morito M, Odagiri S, Iwado M, Mikami F, Miyazaki H, Nanba T and Takei Y : Family support with attention to the sensory sensitivities of children with sensory processing disorder associated with autism spectrum disorder. *Kawasaki Medical Welfare Journal*, **27**(1), 13-25, 2017. (In Japanese with English abstract)
 6. World Health Organization : *International Classification of Functioning, Disability and Health*. World Health Organization, Geneva, 2001.
 7. World Health Organization : *International Classification of Functioning, Disability and Health : Children & Youth Version*. World Health Organization, Geneva, 2007.
 8. Mita T, Mikami F, Kashibe K and Imabayashi H : Assessment of functioning in university life using the international classification of functioning, disability and health (ICF) and physical activity intensity estimated by heart rate recordings : A case study of university student with motor disabilities. *Kawasaki Medical Welfare Journal*, **18**(2), 401-413, 2009. (In Japanese with English abstract)
 9. Mita T, Mikami F, Sugimoto A, Oda K, Mita K, Okada M and Okada K : Relationship between body functions and life domains of patients in residential institutions for children with physical disabilities. *Japan Journal of Medical Informatics*, **30**(6), 327-335, 2011. (In Japanese with English abstract)
10. Mita T, Mikami F, Sugimoto A, Oda K, Mita K, Okada M, Okada K and Egusa Y : Functioning and disabilities of patients in Japanese institutions for children with physical disabilities (Ⅱ) : Assessment of social functioning ability using the ICF. *Journal of Severe Motor and Intellectual Disablities*, **36**(3), 399-408, 2011. (In Japanese with English abstract)
11. Mita T, Mikami F, Sugimoto A, Oda K, Mita K, Okada M, Okada K and Egusa Y : Functioning and disabilities of patients in Japanese institutions for children with physical disabilities (Ⅲ) : Assessment of participation using the ICF. *Journal of Severe Motor and Intellectual Disablities*, **36**(3), 409-416, 2011. (In Japanese with English abstract)
12. Mita T, Mikami F and Okada M : Compatibility between independent activities in the course of study for schools for special needs education and ICF categories. *Kawasaki Journal of Medical Welfare*, **17**(2), 88-95, 2012.
13. Mita T, Mikami F, Okada M, Mita K, Okada K and Ando K : Individual teaching plan in school for special needs education reviewed from an aspect of ICF. *Japan Journal of Medical Informatics*, **29**(2), 75-81, 2009. (In Japanese with English abstract)
14. Mikami F and Miyazaki H : Development of a search support system of functioning using the International Classification of Functioning, Disability and Health (ICF) and its application. *Kawasaki Medical Welfare Journal*, **27**(1), 115-128, 2017. (In Japanese with English abstract)