Abstract. [Purpose] This study aimed to investigate the prevalence of secondary impairments in adults with cerebral palsy. [Subjects and Methods] The study sample included 52 adults with cerebral palsy who attended a convalescent or rehabilitation center for disabled individuals or a special school for physical disabilities in South Korea. [Results] The univariate analysis showed that the Gross Motor Functional Classification System level was a significant predictor of spondylopathies, general pain, arthropathies, and motor ability loss. The prevalence of these impairments at Gross Motor Functional Classification System level I and II was low compared with the prevalence found at Gross Motor Functional Classification System level III–V. The prevalence of secondary impairments among adults with cerebral palsy at Gross Motor Functional Classification System level III–V was high: loss of motor ability, 42.3%; spondylopathies, 38.4%; general pain, 32.7%; and arthropathies, 28.8%. [Conclusion] In this study, adults with severe cerebral palsy showed a high prevalence of motor ability loss, spondylopathies, arthropathies, and pain. It is necessary to develop intervention programs to prevent secondary impairments in adults with cerebral palsy.

Key words: Adults with cerebral palsy, Chronic disease, Gross motor function classification system

INTRODUCTION

The life expectancy of children with cerebral palsy (CP) is increasing rapidly and most live into adulthood. Aging and the increase in life expectancy is associated with an increased prevalence of health problems, and this results in an increase in social and economic burdens. The complex characteristics of CP are a potential cause of the high prevalence of chronic conditions in adults. A variety of disabilities may occur, including difficulty swallowing; excessive salivation; respiratory disorders; eating problems; gastrointestinal disorders such as gastroesophageal reflux disease, constipation, and fecal incontinence; urogenital disorders such as urinary tract infection and incontinence; skin disorders such as bedsores; malocclusion of the teeth; speech and language disorders; communication disorders such as dysarthria; sleep disorders; behavioral problems; and learning disabilities.

The Healthy People 2020 initiative suggested that individuals with lifelong disabilities of childhood onset, such as CP, should transition from pediatric health care to appropriate, ongoing community-based adult health care. Given the increase in life expectancy of children with CP, physical therapists should be capable of providing appropriate services and interventions that children with CP need to prepare for adult life. Physical therapists working in adult practice settings should be willing and prepared to provide services to people with lifelong disabilities, and several authors have suggested various roles...
and interventions for physical therapists to use when working with adolescents and adults. The starting point is to assess the current status of the problem. Thus, the prevalence of health problems in adults with CP should be determined. However, the evidence-based information available in this area is limited. The data available are focused on health conditions such as change in motor function and orthopedic issues. The decline in motor function has been reported by several studies. The survey results in one report showed that of 221 adults with CP in Sweden, 80% had contractures and 18% had pain every day. The data and reports related to health problems in adults with CP are insufficient compared with those for the general population.

The purpose of this study was to investigate the health problems that develop in adults with CP and the differences in prevalence of health problems across levels of the Gross Motor Functional Classification System (GMFCS). The International Classification of Function, Disability, and Health (ICF) recommends that disabilities be explored in a framework based on activity limitations and participation restrictions. Therefore, if health problems could be presented according to the GMFCS, which is familiar to physical therapists, then the evidence for providing health care services to adults with CP would be more understandable.

SUBJECTS AND METHODS

The study sample was comprised of 53 adults with CP (mean age: 32.18 years; standard deviation: 14.10 years). General characteristics of subjects are presented in Table 1. This study involved a secondary analysis of data on the status of support services and policy for people with brain lesions conducted by the Ministry of Health and Welfare of Korea. The survey was performed according to the laws on the use of statistics in Korea, including those related to confidentiality. The parents of adults with CP provided written informed consent. Sampling of the resident area was based on a registry of disabled individuals covered by the Welfare of Disabled Persons Act in Korea. Subjects included: (a) individuals registered as having a brain lesion; (b) individuals diagnosed with CP by a doctor; (c) age greater than 18 years, and (d) GMFCS levels I to V. Although a reason for exclusion, no cases were excluded because of missing data on the survey. The total sample size included 306 individuals with brain lesions and 185 with CP. The subjects were divided into two groups to examine the effect of GMFCS levels I–II and III–V on health.

A univariate logistic regression analysis was performed to examine the influence of GMFCS level on the prevalence of health problems by using SPSS 21.0 software. P values less than 0.05 were considered statistically significant.

RESULTS

The univariate analysis results showed that the GMFCS level was a significant predictor of spondylopathies, general pain, arthropathies, and motor ability loss. The detailed results of the univariate logistic regression analysis are presented in Table 2.

DISCUSSION

The purpose of this study was to investigate the prevalence of secondary impairments among adults with CP. The prevalence of spondylopathies, arthropathies, motor ability loss, and pain at GMFCS level I–II was low compared to the prevalence at level III–V. The prevalence of secondary impairments in adults at level III–V was high: motor ability loss, 42.3%; spondylopathies, 38.4%; general pain, 32.7%; and arthropathies, 28.8%. This result was similar to that of a previous estimate that 31.5% of US adolescents had one or more chronic conditions.

| Table 1. Characteristics of individuals with CP |
|-----------------------------------------------|
| Characteristics | Category | Frequency (%) |
|-----------------|----------|---------------|
| Gender          | Male     | 33 (62.3)     |
|                 | Female   | 20 (37.7)     |
| Age (years)     |          | 31.18 ± 14.10*|
| Level of education |         |               |
| No education    |          | 4 (7.6)       |
| Elementary school |         | 4 (7.6)       |
| High school     |          | 30 (56.6)     |
| Above college   |          | 15 (28.2)     |
| Marriage status |          |               |
| No marriage     |          | 39 (73.6)     |
| Living with spouse |       | 11 (20.8)     |
| Divorce         |          | 3 (5.6)       |

*Mean ± standard deviation
Although many studies have reported secondary conditions such as obesity\(^{10}\), metabolic dysregulation\(^{11}\), and dental disorders\(^{12}\), no significant differences according to the severity of CP were observed in this study. Pain is a common secondary condition in adults with CP, and leads to impaired walking ability and functional activity\(^{13}\). Pain in adults with CP is related to musculoskeletal problems, such as contractures, spasticity, orthopedic deformity, weakness, and fatigue, as well as to gastrointestinal disorders\(^{14}\). In this study, participants at GMFCS level I–II had 0.176 times the prevalence of general pain when compared with those at GMFCS level III–V.

The prevalence of arthropathies and spondylopathies was found to be high. Adults with CP develop spondylopathies and arthropathies with increasing age. Suh et al. reported a significant difference in the sagittal spinopelvic parameters between CP and normal control groups\(^{15}\). Tosi et al. reported that 27% of adults with CP had osteoarthritis compared to only 4% of non-disabled people\(^{14}\). Persson-Bunke et al. found that the incidence of scoliosis increased with GMFCS level and age\(^{16}\).

In this study, the prevalence of spondylopathies was 0.288 times higher in participants at GMFCS level I–II than in those at level III–V, and the prevalence of arthropathies was 0.141 times higher for those at GMFCS level I–II. The reasons for the high prevalence were muscle imbalance, spasticity, and postural asymmetry.

In this study, the loss of motor ability was the most common secondary impairment in adults with CP. The degree of motor ability loss was especially high at higher levels of GMFCS. Many studies reported that adults with CP may experience age-related changes earlier in life than their non-disabled peers\(^{15}\). Change and decline in muscle size and properties during adulthood contribute to an early loss of mobility. Peterson et al. suggested that premature sarcopenia, obesity, and sedentary behavior lead to decreased movement quality\(^{10}\). Persson-Bunke et al. found that the incidence of scoliosis increased with GMFCS level and age\(^{16}\). In summary, adults with CP are believed to have more chronic disease than their peers. Specifically, adults with CP showed a high prevalence of motor ability loss, spondylopathies, arthropathies, and pain. These changes, as well as premature sarcopenia, contribute to the loss of motor ability. In addition, the increase in spondylopathies, arthropathies, and related pain were major secondary problems. Chronic diseases in adults with CP were more common at higher GMFCS levels. Thus, it is necessary to develop intervention programs to prevent secondary impairments in adults with CP.

The results of this study can be affected by several factors such as age, treatment experience, and parental response to the survey. However, the study was not analyzed on the basis of these factors. Future studies will be needed to identify differences across GMFCS levels according to age and treatment experience.

### Table 2. The results of univariate logistic regression analysis

| Problem Category     | Level 1–2 Yes (%) | Level 1–2 No (%) | Level 3–5 Yes (%) | Level 3–5 No (%) | OR    |
|----------------------|-------------------|------------------|-------------------|------------------|-------|
| Spondylopathies      | 20 (38.4)         | 7 (13.5)         | 12 (23.1)         | 13 (25.0)        | 0.289* |
| General pain         | 17 (32.7)         | 16 (30.8)        | 3 (5.8)           | 16 (30.8)        | 0.176* |
| Arthropathies        | 15 (28.8)         | 18 (34.6)        | 2 (3.8)           | 17 (32.7)        | 0.141* |
| Muscle disease       | 10 (19.2)         | 23 (44.2)        | 0 (0.0)           | 19 (36.5)        | 0.000 |
| Obesity              | 10 (19.2)         | 23 (44.2)        | 4 (7.7)           | 15 (28.8)        | 0.613 |
| Loss of motor ability| 22 (42.3)         | 11 (21.2)        | 4 (7.7)           | 15 (28.8)        | 0.133* |
| Hypertension         | 4 (7.7)           | 29 (55.8)        | 5 (9.6)           | 14 (26.9)        | 2.589 |
| Allergic Rhinitis    | 9 (17.3)          | 26 (46.2)        | 4 (7.7)           | 15 (28.8)        | 0.711 |
| Depression           | 9 (17.3)          | 24 (46.2)        | 4 (7.7)           | 15 (28.8)        | 0.711 |
| Dental problem       | 15 (28.8)         | 18 (34.6)        | 7 (13.5)          | 12 (23.1)        | 0.700 |
| Gastrointestinal disorder | 7 (13.5) | 26 (46.2) | 2 (3.8) | 17 (32.7) | 0.437 |

*p<0.05
ACKNOWLEDGEMENT

This work was supported by the Research Fund of Ulsan College in Korea.

REFERENCES

1) Hutton JL, Pharoah PO: Life expectancy in severe cerebral palsy. Arch Dis Child, 2006, 91: 254–258. [Medline] [CrossRef]
2) Bodenheimer T, Chen E, Bennett HD: Confronting the growing burden of chronic disease: can the U.S. health care workforce do the job? Health Aff (Millwood), 2009, 28: 64–74. [Medline] [CrossRef]
3) Horsmann HM, Hosalkar H, Keenan MA: Orthopaedic issues in the musculoskeletal care of adults with cerebral palsy. Dev Med Child Neurol, 2009, 51: 99–105. [Medline] [CrossRef]
4) Orlin MN, Cicirello NA, O’Donnell AE, et al.: The continuum of care for individuals with lifelong disabilities: role of the physical therapist. Phys Ther, 2014, 94: 1043–1053. [Medline] [CrossRef]
5) Thomas AD, Rosenberg A: Promoting community recreation and leisure. Pediatr Phys Ther, 2003, 15: 232–246. [Medline] [CrossRef]
6) Palisano RJ, Copeland WP, Galuppi BE: Performance of physical activities by adolescents with cerebral palsy. Phys Ther, 2007, 87: 77–87. [Medline] [CrossRef]
7) Compton-Griffith KN, Cicirello NA, Turner A: Physical therapists’ perceptions of providing services to adults with childhood-onset neuromotor disabilities. Phys Occup Ther Pediatr, 2011, 31: 19–30. [Medline] [CrossRef]
8) Andersson C, Mattsson E: Adults with cerebral palsy: a survey describing problems, needs, and resources, with special emphasis on locomotion. Dev Med Child Neurol, 2001, 43: 76–82. [Medline] [CrossRef]
9) Park EY, Kim WH: Structural equation modeling of motor impairment, gross motor function, and the functional outcome in children with cerebral palsy. Res Dev Disabil, 2013, 34: 1731–1739. [Medline] [CrossRef]
10) Peterson MD, Gordon PM, Hurvitz EA: Chronic disease risk among adults with cerebral palsy: the role of premature sarcopenia, obesity and sedentary behaviour. Obes Rev, 2013, 14: 171–182. [Medline] [CrossRef]
11) Peterson MD, Gordon PM, Hurvitz EA, et al.: Secondary muscle pathology and metabolic dysregulation in adults with cerebral palsy. Am J Physiol Endocrinol Metab, 2012, 303: E1085–E1093. [Medline] [CrossRef]
12) Martinez-Mihi V, Silvestre FJ, Orellana LM, et al.: Resting position of the head and malocclusion in a group of patients with cerebral palsy. J Clin Exp Dent, 2014, 6: e1–e6. [Medline] [CrossRef]
13) Opheim A, Jahnson R, Olsson E, et al.: Walking function, pain, and fatigue in adults with cerebral palsy: a 7-year follow-up study. Dev Med Child Neurol, 2009, 51: 381–388. [Medline] [CrossRef]
14) Tosi LL, Maher N, Moore DW, et al.: Adults with cerebral palsy: a workshop to define the challenges of treating and preventing secondary musculoskeletal and neuromuscular complications in this rapidly growing population. Dev Med Child Neurol, 2009, 51: 2–11. [Medline] [CrossRef]
15) Suh SW, Suh DH, Kim JW, et al.: Analysis of sagittal spinopelvic parameters in cerebral palsy. Spine J, 2013, 13: 882–888. [Medline] [CrossRef]
16) Persson-Bunke M, Hägglund G, Lauge-Pedersen H, et al.: Scoliosis in a total population of children with cerebral palsy. Spine, 2012, 37: E708–E713. [Medline] [CrossRef]