

## The ages and stages questionnaire: screening for developmental delay in the setting of a pediatric outpatient clinic

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**Purpose :** Early identification of developmental disabilities allows intervention at the earliest possible point to improve the developmental potential. The Ages and Stages Questionnaire (ASQ), a parent-completed questionnaire, can be used as a substitute for formal screening tests. The purpose of this study was to evaluate the validity of the Korean version of the ASQ (K-ASQ) as a screening tool for detecting developmental delay of young Korean children in the setting of a busy pediatric outpatient clinic.

**Methods :** Parents completed the K-ASQ in the waiting room of the pediatric outpatient clinic of St. Mary's Hospital, Catholic University Medical College. Out of 150 completed the ASQ, 67 who were born term and had no previous diagnosis of developmental delay, congenital anomalies, or neurological abnormalities were enrolled. The cut-off values of less than 2 standard deviations (SD) below the mean for the ASQ were used to define a "fail", and children who failed in one or more domains tested were classified as "screen-positive". Diagnosis of developmental delay was made when the developmental indices fell below -1 SD of the Bayley Scales of Infant Development-II.

**Results :** (1) The mean age of children was 16.4±7.4 months. Ten children (14.9%) were small-for-gestational age infants. The mean birth weight and gestational age were 3.1±0.6 kg and 38.8±1.4 weeks. Nine children (13.4%) were twins and 33 (49.0%) were male. The mean maternal education in years was 13.6±2.4, and 31.3% had full-time jobs. The time for completing the ASQ was 10.2±3.0 minutes. (2) Seventeen children (25.4%) were classified as screen-positive, four of them were delayed in development. Among eight children diagnosed with developmental delay, four were screen-positive and the other four were screen-negative by the ASQ. (3) The test characteristics of the ASQ were as follows: sensitivity (50.0%); specificity (78.0%); positive predictive value (23.5%); negative predictive value (92.0%).

**Conclusion :** The high negative predictive value of the K-ASQ supports its use as a screening tool for developmental delay in the setting of a pediatric outpatient clinic. (*Korean J Pediatr* 2007;50:1061-1066)

**Key Words :** Ages and Stages Questionnaire, Developmental screening, Parents, Questionnaire, Outpatient clinic

### Introduction

Early identification of developmental disabilities by timely and periodic assessment of children allows intervention at the earliest possible point to improve developmental potential<sup>1)</sup>.

Research has demonstrated not only that intervention programs are cost-effective and have lifelong benefits, but also that developmental attainment is maximized when intervention is started early<sup>1,2)</sup>. Therefore, identification of developmentally delayed children at an early age, even during infancy if possible, is advocated<sup>1)</sup>. Appropriately, timed developmental assessments can also help to identify developmental risk factors and anticipatory guidance to provide parents with strategies for promoting optimal developmental outcomes<sup>3)</sup>.

Standardized developmental screening tests should be

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considered for all children under developmental surveillance<sup>1)</sup>. This is because only 20% to 30% of developmentally impaired children are identified, before school age, by developmental surveillance of primary care physicians who rely on clinical judgment alone<sup>4)</sup>, and standardized developmental screening tests have been shown to improve the rate and accuracy of identification of developmental delays<sup>5-7)</sup>.

The pediatrician’s office is the only place where most children younger than 5 years of age are seen and may be an ideal setting for developmental and behavioral screening. However, a busy pediatric outpatient clinic is not necessarily the appropriate place for such evaluation using the standardized screening tests for developmental surveillance. Time constrains, the lack of personnel and the burden of cost are major obstacles for pediatricians when attempting to provide standardized screening tests that are often time consuming, complicated to administer and require certain specific instruments and direct observation of child’s skill<sup>8,9)</sup>.

Parent-completed questionnaires can be used as a substitute for screening tests. Parents can provide accurate information about their child’s development<sup>10-16)</sup>. The Ages and Stages Questionnaire is a parent-completed questionnaires used for estimation of the developmental status of infants and young children from four to 60 months of age<sup>17)</sup>.

The purpose of this study was to evaluate the validity of the Korean Ages and Stages Questionnaire as a screening tool for detecting developmental delay of young Korean children in the setting of a busy pediatric outpatient clinic.

## Materials and Methods

### 1. Materials

One hundred and fifty subjects were recruited for this study at the time of their visit to the pediatric outpatient clinic at St. Mary’s Hospital, the Catholic University Medical College. Thirty-nine children were excluded because of pre-existing developmental problems, neurological abnormalities such as a seizure disorder, congenital anomalies, genetic disorders, or prematurity, and 10 children over 30 months of age were also excluded. After excluding 34 children who were not able to take the BSID-II, 67 children were enrolled in this study.

### 2. Methods

The age at the ASQ, gestational age and body weight at

birth, multiple gestation, maternal education years and occupation data were collected. The parents completed the K-ASQ sheet while they were waiting in the pediatric outpatient clinic. Completed questionnaires were scored by a doctor according to established procedures in a manual for each of the following five domains: communication, gross motor, fine motor, problem-solving and personal/social development<sup>17)</sup>. Cut-off values of less than 2 SD below the mean for each of the five domains were used to define “fail” and children who failed in one or more domains were classified as “screen-positive” for the ASQ.

The BSID-II<sup>18)</sup> was administered in all 67 children, and the diagnosis of developmental delay was made when the Bayley mental or psychomotor developmental indices fell below -1 SD from the mean. Characteristics of the children who were screen-positive for the ASQ were analyzed, with a focus on the five domains of development. The sensitivity, specificity, positive predictive value and negative predictive value of ASQ were compared to the Bayley developmental assessment.

## Results

### 1. Demographic and Descriptive Data

The age ranged from six to 30 months (median 14 mo; 16.4

**Table 1.** Demographics of Study Population

Characteristics	(n=67)
Age at ASQ, range (median), mo	6-30 (14)
mean ± SD	16.4 ± 7.4
Small-for-gestational age, n (%)	10 (14.9)
Birth weight, range (median), kg	1.6-4.6 (3.0)
mean ± SD	3.1 ± 0.6
Gestational age at birth, wk	38.8 ± 1.4
Twin, n (%)	9 (13.4)
Sex, n (%)	
Male	33 (49.0)
Female	34 (51.0)
Maternal education, Mean SD, yr	13.6 ± 2.4
High school incomplete or less, n (%)	6 ( 9.0)
High school graduate	22 (32.8)
College graduate	5 ( 7.5)
University graduate	26 (38.8)
No answer	8 (11.9)
Mother at work, n (%)	21 (31.3)
Time to complete questionnaire, range (median), min	7 ± 20 (10)
mean ± SD	10.2 ± 3.0

Abbreviation : ASQ, the Ages and Stages Questionnaire

$\pm 7.4$  mo). Ten children (14.9%) were small-for-gestational age infants, the mean birth weight was  $3.1 \pm 0.6$  kg, gestational age  $38.8 \pm 1.4$  weeks. Nine (13.4%) were born as one of a twin pair, and thirty-three children (49.0%) were boys.

The years of maternal education ranged from six to 16 ( $13.6 \pm 2.4$ ); 53 (79.1%) were high school graduates or more highly educated. Mothers of 21 children (31.3%) had full-time jobs. The mean time required for completing the ASQ was  $10.2 \pm 3.0$  minutes, with a range of 7 to 20 minutes (Table 1).

## 2. Characteristics of Children with a Screen Positive ASQ

Seventeen children (25.4% of the 67 enrolled children) were classified as "screen-positive" by the ASQ; 14 children failed in one domain, three children failed in two domains of the ASQ. Eight children (11.9%) failed the communication domain, 2 children (3.0%) the gross motor, three (4.5%) the fine

motor, three (4.5%) the problem solving, and four children (6.0%) failed the personal/social domain. Only one child out of eight children who failed the communication domain of the ASQ was considered to have developmental delay. The two children who failed the gross motor domain of the ASQ were considered to have delayed development. The three children who failed the fine motor domain of the ASQ were not considered developmentally delayed. One of three children that were screen-positive for the problem-solving domain of the ASQ was diagnosed with developmental delay by the BSID-II. Two children out of four that were screen-positive for the personal/social domain were considered to have developmental delay (Table 2).

## 3. Psychometric Values of the ASQ

Among the 17 screen-positive children by the ASQ, four were considered to have developmental delay; another 13

**Table 2.** Data of 17 Children of Screen Positive in Ages and Stages Questionnaire

Case No.	Age (mo)	Domains of ASQ					BSID-II
		Communi-cation	Gross motor	Fine motor	Problem solving	Personal/social	
1	12	Pass	Fail	Pass	Pass	Fail	Delayed
2	30	Fail	Pass	Pass	Pass	Pass	Normal
3	20	Fail	Pass	Pass	Pass	Pass	Normal
4	24	Pass	Pass	Pass	Fail	Fail	Delayed
5	8	Fail	Pass	Pass	Pass	Pass	Normal
6	12	Fail	Pass	Pass	Pass	Pass	Normal
7	6	Pass	Pass	Fail	Fail	Pass	Normal
8	16	Pass	Pass	Pass	Pass	Fail	Normal
9	24	Fail	Pass	Pass	Pass	Pass	Normal
10	24	Fail	Pass	Pass	Pass	Pass	Normal
11	12	Pass	Pass	Pass	Pass	Fail	Normal
12	30	Pass	Pass	Fail	Pass	Pass	Normal
13	10	Fail	Pass	Pass	Pass	Pass	Normal
14	24	Fail	Pass	Pass	Pass	Pass	Delayed
15	18	Pass	Fail	Pass	Pass	Pass	Delayed
16	12	Pass	Pass	Pass	Fail	Pass	Normal
17	8	Pass	Pass	Fail	Pass	Pass	Normal

Abbreviations : ASQ, Ages and Stages Questionnaire; BSID-II, Bayley Scales of Infants Development 2nd edition; Delayed, diagnosed with delayed development by the BSID-II

**Table 3.** Characteristics of the Ages and Stages Questionnaire

		BSID-II		Total	Sensitivity	Specificity	PPV	NPV
		Delayed	Normal					
ASQ	Positive	4	13	17	0.50	0.78	0.24	0.92
	Negative	4	46	50				
	Total	8	59	67				

Abbreviation; ASQ, Ages and Stages Questionnaire; BSID-II, Bayley Scales of Infants Development 2nd edition; PPV, positive predictive value; NPV, negative predictive value

were classified as normal by the BSID-II. Among fifty children who were screen-negative for the ASQ, four were diagnosed with developmental delay by the BSID-II. The sensitivity, specificity, positive predictive value, and negative predictive values of the ASQ were 0.50, 0.78, 0.24 and 0.92, respectively (Table 3).

## Discussion

Developmental surveillance emphasizes an approach of systematic assessment of parental concerns. It includes taking a developmental history, making skilled observations and determining the need for additional instrument-based formal assessments. Developmental surveillance is preferably accomplished using a parent checklist or questionnaire such as the ASQ<sup>17)</sup>, the Parents' Evaluation of Developmental Status (PEDS)<sup>19)</sup>, and the Child Development Inventories (CDI)<sup>20)</sup>. These tests have been shown to have excellent psychometric properties with the advantage of requiring much less time from the pediatrician than the formal standardized screening tools that require direct examination<sup>10-16)</sup>.

Formal screening assessments such as the Denver-II screening test<sup>21)</sup>, Bayley Infant Neurodevelopmental Screener (BINS)<sup>22)</sup>, Battelle Developmental Inventory (BDI)<sup>23)</sup>, Early Language Milestone Scale (ELM, Scale-2)<sup>24)</sup> and the Brigance Screens<sup>25)</sup> involve direct examination of the child's skills, and therefore have limited utility for a routine screening tool in a busy pediatric outpatient clinic.

The ASQ is a screening tool composed of 19 sets of questionnaires covering the age range of four to 60 months. The questionnaire targets the 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 27, 30, 33, 36, 42, 48, 54, and 60 month age levels. A set of the ASQ is composed of 30 questions; six questions for each of five domains (communication, gross motor skills, fine motor skills, problem-solving and personal/social skills). The questions can be answered "yes" (10 points), "sometimes" (5 points) or "not yet" (0 points). The maximum score is 60 points within each domain. Referral for further developmental evaluation is recommended if the score falls below a given cut-off score (set at -2 SD from mean) in any domain<sup>17)</sup>.

It is important to note that the ASQ can be administered in a pediatric outpatient clinic while patients are waiting, and completed in a short period without assistance from the medical staff. The mean time required to complete the questionnaires was 10.2±3.0 min, with a range from seven to 12 min. This allows the use of the ASQ as a routine pro-

cedure for developmental surveillance in a busy pediatric outpatient clinic.

The percentage of mothers that were educated through high school or more was high; the mean number of years of education for the mothers was 13.6 with over two-thirds of them classified as high-school graduates or more highly educated. The majority of subjects enrolled in this study were Seoul metropolitan area residents. Current reports have shown that the accuracy of parental reports, about their child's development, does not change by differences in socioeconomic status, parental well being or geographic location<sup>10-15)</sup>; therefore, the characteristics of our study population might not affect the accuracy of the ASQ for identifying delayed development in young Korean children in other locations. However, it is necessary to extend the study subjects to include a wider range of socioeconomic and geographic characteristics.

The twenty-one children, whose mother had full-time jobs, were primarily taken care of by their biological grandmother; nine of them were involved in a part-time baby-sitting program during the day. For these children the grandmother completed the ASQ questionnaires. The developmental characteristics of children according to the methods of care could not be analyzed in this study because of the small sample size and lack of more complicated and comprehensive information.

Seventeen of the children (25.4% of total 67 enrolled this study) were "screen-positive" for the ASQ; 14 children failed in one domain and three failed in two domains of the ASQ. The prevalence of "screen-positive" was lower than the results reported in a recent American report by Rydz et. al<sup>26)</sup>. This is partly because the difference in the study population, including the evaluation of some premature infants. The domain that the children failed most often, on the ASQ, was communication (8; 11.9%), followed by personal/social (4; 6.0%), fine motor and problem solving (3 each; 4.5%), and gross motor (2; 3.0%).

Only one child (12.5%) out of eight children who failed the communication domain of the ASQ was considered to have developmental delay. This finding suggests that language has a wide range of normal in development, and that caution should be used before diagnosing delayed development in children with delays in communication. Motor development has been shown to be related to later cognitive development<sup>27, 28)</sup>. The two children that failed the gross motor domain of the ASQ were both diagnosed with delayed development. However, the three children who failed the fine motor domain

were not considered to have delayed development in this study. Because our study has the limitation of a small sample size and narrow demographic variability, further studies with a larger number of cases are needed for confirmation of the findings.

50.0% of the children who were screen-positive for the personal/social domain by the ASQ were diagnosed with developmental delay by the BSID-II.

Two children (67.0%) out of three who failed two domains of the ASQ were considered to have developmental delay, in contrast to 14.3% of children (2 out of 14) who failed only one domain of the ASQ were diagnosed with delayed development.

As a "gold standard" for the diagnosis of delayed development, we used the Bayley Scales of Infant Development, second edition (BSID-II). All 67 children took the BSID-II within 1 month of the ASQ to exclude the possibility of changes in the developmental status between the two tests. When considering the fluctuations in performance noted on developmental testing in normal children<sup>29)</sup>, our method of diagnostic evaluation may be another limitation of this study. Some investigators have suggested that in order to evaluate the real accuracy of a screening test, such as the ASQ, a 3-month waiting period representing the real-life delay typically experienced between screening and referral should be implemented<sup>26)</sup>.

Although our study has some limitations, such as a small sample size, narrow range of age, socioeconomic, and geographic variability, the psychometric properties of the ASQ were excellent. There was no significant finding for the ASQ diagnosis of delayed development because the positive predictive value was only 24 percent. However, the high negative predictive value (0.92) of the ASQ supports its use as a good screening test for identifying developmental delay in a busy pediatric outpatient clinic.

Further studies on a more representative population incorporating a larger sample size, wider demographic range and geographic characteristics are necessary for applying the ASQ as a reliable screening tool for routine developmental surveillance in the pediatric primary care setting in Korea.

## 한글 요약

### ASQ : 소아과외래에서의 발달지연 선별검사

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**목적 :** 소아의 발달 장애는 조기에 발견하면 조기 치료가 가능하게 되어 치료 효과가 높아지고 후유 장애를 최소화할 수 있다. 발달 장애의 조기 발견을 위하여 기존에 사용해 오던 정식 발달 선별검사는 대부분 시간이 오래 걸리고, 복잡하며, 의료인력이 추가로 필요하기 때문에 바쁜 소아과 외래에서 모든 소아에게 적용하기는 어렵다. 기존의 발달검사 대신에 부모가 작성한 내용을 토대로 평가하는 발달 설문 양식들 중 Ages and Stages Questionnaire (ASQ)는 60개월 이전의 소아의 발달 선별을 목적으로 개발된 검사이다. 본 연구의 목적은 소아과 외래에서 시행하는 발달 지연의 선별 도구로서 ASQ의 타당성을 알아보기 위한 것이다.

**방법 :** 가톨릭대학교 의과대학 부속 성모병원 소아과 외래를 방문한 소아의 부모에게 진료 전 대기 시간 동안 한국형 ASQ (K-ASQ)를 완성하도록 하였다. 설문지를 완성한 총 150명 중 만삭 출생아이며 이전에 발달지연의 진단을 받은 적이 없고, 기타 선천성 기형, 경련성 질환을 포함한 신경학적 이상, 유전성 질환의 경력이 없는 소아 67명을 대상으로 하였다. K-ASQ는 각 영역별로 평균에서 2 표준편차(SD) 아래 점수보다 낮으면 "실패"로 판정하며, 한 발달 분야 이상에서 "실패"가 있는 경우를 "선별검사 양성"으로 하였다. 최종 발달평가는 Bayley Scales of Infant Development-II (BSID-II)를 사용하여 판단하였으며, 지능 혹은 운동발달 지수가 평균보다 -1 SD 미만인 경우는 발달지연으로 판정하였다. K-ASQ의 결과를 BSID-II와 비교하여 분석하였다.

**결과 :** 1) 대상아의 평균 연령은  $16.4 \pm 7.4$ 개월( $6 \pm 30$ 개월 범위, 중앙치 14개월)이었다. 10명(14.9%)은 출생 시 부당경량아였으며, 평균 출생체중  $3.1 \pm 0.6$  kg, 재태기간  $38.8 \pm 1.4$ 주이었다. 9명(13.4%)이 쌍생아였고, 33명(49.0%)이 남아였다. 대상 소아들의 모친의 평균 교육 기간은  $13.6 \pm 2.4$ 년, 53명(79.1%)이 고등학교 졸업 이상의 학력을 가졌고, 21명(31.3%)이 정규직 근무자였다. ASQ 설문지를 완성하는데 평균  $10.2 \pm 3.0$ 분이 소요되었다. (2) 17명(25.4%)이 ASQ 선별검사 양성이었는데, 그 중 4명은 발달이 지연되었고, 나머지 13명의 발달은 정상이었다. BSID-II로 판정한 발달 지연아 8명 중 4명은 ASQ 선별검사에서도 양성하였고, 다른 4명은 선별검사 음성이었다. ASQ 선별검사 음성인 50명 중 4명이 발달지연으로 판정되었다. (3) BSID-II와 비교한 K-ASQ의 민감도(sensitivity)는 50.0%, 특이도(specificity) 78.0%, 양성 예측치(positive predictive value) 23.5%, 음성 예측치(negative predictive value)는 92.0%로 나타났다.

**결론 :** K-ASQ는 높은 음성 예측치를 보여 소아과 외래에서 소아 발달 지연의 선별 도구로서 사용하는 것이 타당한 것으로 판

단되었다.

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