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# Transition of Extremely Low-Birth-Weight Infants From Adolescence to Young Adulthood

## Comparison With Normal Birth-Weight Controls

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**S**UCCESSFUL TRANSITION TO ADULTHOOD is traditionally viewed as the attainment of the following markers: completion of formal education, entry into the labor force, living independently from the family, and marriage and parenthood.<sup>1,2</sup> The actual level of educational attainment and employment may depend on or be associated with parental education, socioeconomic status, marital harmony, family structure, sex, success at school, and motivation of the individual.<sup>3-7</sup> Thus, reaching adulthood is not merely a process of biological maturation but involves a social construct that is appropriate for a particular society.<sup>1,8-10</sup>

Despite the recent dramatic improvements in survival, extremely low-birth-weight (ELBW, weighing <1000 g) and very low-birth-weight (VLBW, weighing <1500 g) children<sup>11-14</sup> and adolescents<sup>15-22</sup> remain disadvantaged on many measures of cognition, academic achievement, behavior, and social adaptation. Survivors from the early

**For editorial comment see p 695.**

**Context** Traditionally, educational attainment, getting a job, living independently, getting married, and parenthood have been considered as markers of successful transition to adulthood.

**Objective** To describe and compare the achievement and the age at attainment of the above markers between extremely low-birth-weight (ELBW) and normal birth-weight (NBW) young adults.

**Design, Setting, and Participants** A prospective, longitudinal, population-based study in central-west Ontario, Canada, of 166 ELBW participants who weighed 501 to 1000 g at birth (1977-1982) and 145 sociodemographically comparable NBW participants assessed at young adulthood (22-25 years). Interviewers masked to participant status administered validated questionnaires via face-to-face interviews between January 1, 2002, and April 30, 2004.

**Main Outcome Measures** Markers of successful transition to adulthood, including educational attainment, student and/or worker role, independent living, getting married, and parenthood.

**Results** At young adulthood, 149 (90%) of 166 ELBW participants and 133 (92%) of 145 NBW participants completed the assessments at mean (SD) age of 23.3 (1.2) years and 23.6 (1.1) years, respectively. We included participants with neurosensory impairments (ELBW vs NBW: 40 [27%] vs 3 [2%]) and 7 proxy respondents. The proportion who graduated from high school was similar (82% vs 87%,  $P=.21$ ). Overall, no statistically significant differences were observed in the education achieved to date. A substantial proportion of both groups were still pursuing postsecondary education (47 [32%] vs 44 [33%]). No significant differences were observed in employment/school status; 71 (48%) ELBW vs 76 (57%) NBW young adults were permanently employed ( $P=.09$ ). In a subanalysis, a higher proportion of ELBW young adults were neither employed nor in school (39 [26%] vs 20 [15%],  $P=.02$  by Holm's correction); these differences did not persist when participants with disabilities were excluded. No significant differences were found in the proportion living independently (63 [42%] vs 70 [53%],  $P=.19$ ), married/cohabitating (34 [23%] vs 33 [25%],  $P=.69$ ), or who were parents (16 [11%] vs 19 [14%],  $P=.36$ ). The age at attainment of the above markers was similar for both cohorts.

**Conclusion** Our study results indicate that a significant majority of former ELBW infants have overcome their earlier difficulties to become functional young adults.

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postneonatal intensive care era have only now reached young adulthood. Although some aspects of longer-term outcomes on VLBW young adults have been reported in a few studies,<sup>23-28</sup> details of the process of educational, sociological, economic, and personal adaptations of former ELBW infants at young adulthood are virtually unknown.

We report the outcomes at young adulthood of a population-based cohort of former ELBW infants born in central-west Ontario, Canada, and a comparison group of normal birth-weight (NBW) children recruited at age 8 years. We focus in both cohorts on educational attainment, student and/or worker role, and independent living as markers of successful transition to adulthood. We describe and compare the age at attainment of these markers, such as age at finishing school, getting a first job, age at first leaving home, getting married, and becoming a parent.<sup>4,8-10,29</sup> Based on the high prevalence of neurodevelopmental (28%) and school difficulties (special education and/or grade repetition, 58%) reported in this cohort at adolescence (mean [SD] age, 14.0 [1.6] years),<sup>16-18</sup> we hypothesized that compared with NBW peers the ELBW cohort would have a lower level of educational attainment and enrollment in postsecondary education, as well as a lower level of employment. We also hypothesized that independent living and other markers of transition to adulthood would be considerably delayed or not achieved at all.

## METHODS

### Study Participants

At young adulthood, 166 long-term ELBW survivors who weighed 501 to 1000 g at birth and born (1977-1982) to residents of a geographically defined region in central-west Ontario, Canada, were eligible for recruitment into the study. These children were followed up longitudinally from birth, and we have previously reported on their outcomes at ages 3 years,<sup>30</sup> 5 years,<sup>31</sup> 8 years,<sup>12,32</sup> and at adolescence.<sup>16-18</sup>

At young adulthood, 145 NBW participants born at term were eligible for the study. They were recruited at age 8 years from a random list of children provided by the local school boards and matched for sex, age, and social class to each index child,<sup>12,32</sup> and followed up longitudinally to adolescence.<sup>16-18</sup>

Parents of both ELBW and NBW young adults completed questionnaires at the same time as their children.

### Interview Protocol

Young adults in both groups were recalled when aged between 22 and 25 years for face-to-face interviews conducted by masked, trained lay professional interviewers, using scripted questions with a skip pattern and administered in a standard order. The majority of interviews (93%) were conducted in private at McMaster Children's Hospital, Hamilton, Ontario. Although 90% of the young adults lived in Ontario, they traveled between 10 and 350 km for the interviews; the remaining traveled greater distances and all were reimbursed for their travel expenses. Information on young adults who were severely impaired and unable to respond was obtained from parents. Interviews were conducted between January 1, 2002, and April 30, 2004. Our study was approved by the research ethics board of Hamilton Health Sciences and written informed consent was obtained from all young adults and their parents.

### Questionnaires

The following information was obtained on both cohorts using questions derived primarily from the Ontario Child Health Study Questionnaires.<sup>33</sup>

**Young Adult Participants.** Demographic information included age, marital status, current living arrangements, and household membership; partner relationships, such as marriage/common-law marriage; history of pregnancies in the female participants; and pregnancies in partners of male adolescents. Educational status, such

as high school completion, postsecondary education, highest degree/diploma obtained, and current enrollment in a postsecondary university, college, or apprenticeship program, was obtained. The work status in young adults was determined by current employment status, part-time or full-time employment, and type of employment; if not employed, reasons for unemployment or inability to work were obtained.

**Parent Participants.** Maternal and paternal education, occupation, and socioeconomic status, classified according to the Hollingshead 4-factor index, were obtained.<sup>34</sup> Information on parental race (white or nonwhite) and place of birth was based on parent report and obtained by the research nurse at the time of enrollment as part of the demographic information.

**Canadian Population Data.** Data on sociodemographic, educational, employment, and marital status of the study population were also compared with age-matched Canadian population data obtained from the most current census from *Statistics Canada* (2001)<sup>10</sup> and recent Youth in Transition Survey reports, a longitudinal survey of more than 22 000 Canadian youth aged 18 to 22 years.<sup>6,7</sup>

### Definitions

Secondary schools in the Ontario education system consist of 3 streams: a 5-year advanced level (Ontario Academic Credits), a prerequisite for university entrance; a 4-year general level; and a 4-year basic level program, which focused on vocational and life skills but did not qualify for entrance to postsecondary education.

An undergraduate degree was conferred after a 3- to 4-year program. Graduate school (eg, law, dentistry, medicine, business) was a further 2- to 4-year program. Colleges of Applied Arts and Technology required a general level high school certificate and conferred a diploma after a 2- to 3-year program that produced job-ready, skilled workers. Trades apprenticeships and certificates for shorter

(≤1 year) workplace-oriented study programs were also conferred by colleges.

Individuals who considered their job as their primary activity, excluding students with part-time jobs, were classified according to Hollingshead job-category classification.<sup>34</sup> Independent living was defined as living away from the parental home, excluding school-related residence. Information regarding assisted living, group home, or institution was obtained where applicable.

**Statistical Analyses**

χ<sup>2</sup> Tests of significance were used to assess differences in categorical variables between the ELBW and NBW participants and analysis of variance was used to compare mean differences between groups. Final educational attainment of young adults and their parents was collapsed into 3 categories: less than high school, high school graduation and/or some postsecondary education, and completed postsecondary graduation. Young adults still in school were excluded from this analysis. The highest levels of educational attainment of young adult and either parent were regrouped to develop parent-young adult dyads.

Unless stated otherwise, data are presented on all participants, inclusive of those participants with neurosensory impairments. Although exact *P* values (*P*<.05) are provided in the text or tables where applicable, due to multiple testing, Holm’s correction<sup>35</sup> was used for key variables of primary hypotheses to establish statistical significance. Secondary analyses were not subjected to Holm’s correction. SPSS version 11.0 (SPSS Inc, Chicago, Ill) was used for all statistical analyses.

**RESULTS**

**Study Participants**

Between 1977 and 1982, 179 of 397 infants who weighed 501 to 1000 g at birth survived to hospital discharge (survival rate, 45%)<sup>30</sup>; subsequently, 13 children died postdischarge (6 before age 3 years, 4 severely impaired children between ages 9 and 16 years, and 3 in the

late teenage years [1 severely impaired, 1 unintentional drowning, and 1 car crash]). Of the 166 eligible long-term survivors, 9 were lost to follow-up and 8 refused (6 of these nonparticipants had neurosensory impairments [2 with mild cerebral palsy, 3 with autism, and 1 with cognitive impairment], no information was available on 5 participants, and the remaining 6 had no significant problems). Thus, the outcome is reported on 149 (90%) of 166 surviving young adults, including parental proxy responses for 7 participants who were severely disabled. Neurosensory impairments were identified in 40 participants (27%): cerebral palsy (n=20, 4 nonambulatory), autism (n=2), unilateral blindness (n=8), bilateral blindness (n=11), and significant cognitive impairment (n=14) (not mutually exclusive). The mean IQ at adolescence (aged 12-16 years) for ELBW participants with neurosensory impairments was 80 (SD, 25; median, 87; range, 43-132), and for ELBW participants without impairments, the mean IQ was 95 (SD, 12). Parental questionnaires were completed by 142 (88%) of 161 parents. The majority of participants were mothers (92%). Except for lower maternal education among those participants who were lost or refused (<high school, 50% vs 21%; *P*=.02), no statistically significant differences were found in single-parent status, mean birth weight, sex, and neurosensory impairments between participants and nonparticipants.

No deaths occurred among the 145 NBW cohort followed up longitudinally from age 8 years, but 5 NBW participants were lost to follow-up and 7 refused to participate (none had impairments). The remaining 133 (92%) of 145 NBW young adults participated in the study, including all 3 (2%) with neurosensory impairments. Parental questionnaires were completed by 130 (92%) of 141 NBW participants, primarily mothers (97%). No demographic differences were observed between participants and nonparticipants.

A record search of the Provincial Ministry for Vital Statistics revealed no

further deaths among the 14 lost survivors in the 2 groups.

**Neonatal and Current Parental Sociodemographics**

Mean (SD) birth weight for the ELBW cohort was 841 (124) g and mean (SD) gestational age was 27.1 (2.3) weeks (TABLE 1). The majority of ELBW and NBW participants were white (140 [94%] and 129 [97%], respectively) and from 2-parent families (116 [82%] and 103 [79%], respectively). Approximately half of both cohorts were from the upper 2 socioeconomic status categories.<sup>34</sup> The mean (SD) age at assessment for ELBW and NBW participants was 23.3 (1.2) years and 23.6 (1.1) years, respectively (*P*=.02).

**Educational Achievements to Date**

Only the highest completed educational level was reported; those participants still pursuing postsecondary education were included in the completed high school level (TABLE 2). The mean (SD) total years of education was significantly different between groups (ELBW vs NBW: 13.9 [2.3] vs 14.5 [2.3] years; *P*=.02 by Holm’s correction; mean difference, -0.61; 95% confidence interval [CI], -1.10 to -0.07) and by sex (male ELBW vs male NBW: 13.4 [2.3] vs 14.5 [2.2] years; *P*=.009; female ELBW vs female NBW: 14.4 [2.2] vs 14.6 [2.3] years; *P*=.51). The 2-way analysis of variance yielded *P*=.01 by group, *P*=.03 by sex, and *P*=.12 by interaction. There were no statistically significant differences between ELBW and NBW groups in the 4 categories of education achieved to date, inclusive of participants who were still at school and pursuing postsecondary education. The proportion who graduated from high school was similar in both groups (ELBW vs NBW: 122 [82%] vs 116 [87%]; *P*=.21) and comparable with the Canadian population (87%). Among high school graduates, ELBW participants were less likely to complete the advanced high school course, a requirement for university entrance (ELBW vs NBW, 36% vs 57%;

**Table 1.** Birth and Current Family Sociodemographic Characteristics of ELBW and NBW Young Adult Participants\*

Characteristics	No. of Young Adult Participants (%)	
	ELBW (n = 149)	NBW (n = 133)
Birth characteristics		
Birth weight, mean (SD), g	841 (124)	3384 (487)
Gestation, mean (SD), wk	27.1 (2.3)	†
<750 g birth weight	40 (27)	NA
<26 wk gestation	33 (22)	NA
Sex, male	67 (45)	60 (45)
Race, white	140 (94)	129 (97)
Neurosensory impairments	40 (27)	3 (2)
Current family characteristics		
Family status (2 parents)	116 (82)	103 (79)
Social class‡		
1-2	68 (47)	71 (56)
3	43 (30)	27 (21)
4-5	34 (23)	30 (23)
Current highest maternal education		
<High school	28 (21)	26 (20)
Completed high school	42 (31)	26 (20)
Partial postsecondary	26 (19)	27 (21)
Completed university/college	38 (28)	49 (38)
Current highest paternal education§		
<High school	26 (22)	26 (26)
Completed high school	25 (21)	18 (18)
Partial postsecondary	20 (17)	18 (18)
Completed university/college	46 (39)	39 (41)
Participants at adulthood		
Survivors assessed	149 (90)	133 (92)
Age at assessment, mean (SD), y	23.3 (1.2)	23.6 (1.1)

Abbreviations: ELBW, extremely low birth weight; NA, not applicable; NBW, normal birth weight.  
 \*For current family characteristics, there were 142 ELBW participants and 130 NBW participants; for maternal education, 134 ELBW participants and 128 NBW participants; and for paternal education, 117 ELBW participants and 101 NBW participants.  
 †Full-term gestation (≥38 weeks).  
 ‡Based on Hollingshead classification.<sup>34</sup>  
 §Paternal refers to predominantly biological or adoptive father (78%) but includes step/common-law father (22%).  
 ||P = .02.

P = .001). The 2-way interaction among advanced high school graduates, group, and sex was significant (P = .008 by Holm's correction); these differences remained (P = .01) when participants with impairments were excluded.

Among ELBW participants with less than a high school education, 11 (50%) of 22 had neurosensory impairments, and 8 (5.4%) of 149 ELBW participants were incapable of being educated and enrolled in special resource classes; none of the NBW participants required this resource. In a subanalysis of post-secondary education, a significantly lower proportion of ELBW participants was enrolled in or had completed university education (ELBW vs NBW, 23% vs 37%; P = .01 by Holm's correction; odds ratio [OR], 1.97; 95% CI, 1.70-2.40).

Sex differences were observed within the ELBW group. Subanalyses of those participants with the lowest education (<high school) revealed a higher proportion of male participants in this category (17 [25%] vs 8 [10%] of female participants, P = .01; OR, 3.15; 95% CI, 2.60-3.60). Male participants were also less likely to be enrolled in or graduated from college or university (male vs female, 49% vs 71%; P = .01; OR, 2.49; 95% CI, 2.15-2.83).

**Table 2.** Educational Attainment to Date by Sex of All ELBW and NBW Young Adult Participants\*

	Male Participants			Female Participants			Total Participants			Canadian Population Norms, %†
	ELBW	NBW	P Value	ELBW	NBW	P Value	ELBW	NBW	P Value	
<b>All ELBW and NBW Participants</b>										
No. of participants	67	60		82	73		149	133		
Total years of education completed, mean (SD), y‡	13.4 (2.3)	14.5 (2.2)	.009	14.4 (2.2)	14.6 (2.3)	.51	13.9 (2.3)	14.5 (2.3)	.02	NA
Highest achievement to date, No. (%)§										
<High school	17 (25)	7 (12)	.07	8 (10)	9 (12)	.29	25 (17)	16 (12)	.06	10
High school	34 (51)	35 (58)		46 (56)	40 (55)		80 (54)	75 (56)		NA
College/trades	14 (21)	11 (18)		22 (27)	13 (18)		36 (24)	24 (18)		34
University	2 (3)	7 (12)		6 (7)	11 (15)		8 (5)	18 (14)		
<b>Participants Still in School  </b>										
No. of participants	17	20		30	24		47	44		
Enrolled in community college, No. (%)¶	8 (47)	5 (25)	.16	13 (43)	8 (33)	.45	21 (45)	13 (29)	.14	44
Enrolled in university, No. (%)	9 (53)	15 (75)		17 (57)	16 (67)		26 (55)	31 (71)		

Abbreviations: ELBW, extremely low birth weight; NA, not available; NBW, normal birth weight.  
 \*Significance of all P values was determined by using the Holm's correction. Highest achievement to date categories were mutually exclusive and included those participants who were still in school.  
 †From the Youth in Transition Survey reports (1979-1981 births).<sup>6,7</sup> The mean age of the cohort was 22 years.  
 ‡Two-way analysis of variance: P = .01 by group (ELBW vs NBW), P = .03 by sex (male vs female), and P = .12 by interaction.  
 §When neurosensory impairments were excluded, P = .05.  
 ¶When neurosensory impairments were excluded, P = .44.  
 ||Includes trades and high school equivalency.

Paired analysis of educational attainment (<high school, high school, or >high school) within young adult/parent dyad by group, excluding those participants still in school, revealed no statistically significant difference between ELBW parents' and young adults' final attainment ( $P = .61$ ) (TABLE 3). However, within the NBW group, young adults achieved significantly higher final attainment than their parents did ( $P = .006$ ).

**Employment Status**

For the 4 categories of employment or in school status, there were no signifi-

cant differences by group ( $P = .09$ ) or when participants with impairments were excluded; however, differences by sex were observed for between-group comparison of female participants only ( $P = .001$ ) (TABLE 4). The 2-way analysis of variance interaction between group and sex was significant ( $P = .01$  by Holm's correction); however, when participants with neurosensory impairments were excluded, the difference became nonsignificant ( $P = .10$ ). There were no differences in part-time or full-time employment for those participants who were permanently employed ( $P = .85$ ); 3 ELBW

participants and none of the NBW participants were employed in sheltered workshops. Data for permanent employment for both ELBW and NBW participants (71 [48%] vs 76 [57%], respectively) were comparable with the Canadian population norms (41%). For young adults with permanent employment, there were no differences between ELBW and NBW participants in occupational prestige ( $P = .25$ ).<sup>34</sup>

In a subanalysis, a higher proportion of ELBW than NBW participants were neither employed nor in school (39 [26%] vs 20 [15%],  $P = .02$  by

**Table 3.** Educational Attainment to Date of ELBW and NBW Young Adult/Parent Dyad Participants\*

Highest Level Completed	No. of Participants (%)					
	ELBW (n = 98)			NBW (n = 85)		
	Young Adult	Parent	P Value	Young Adult	Parent	P Value
<High school	20 (20)	23 (23)	.61	12 (14)	24 (28)	.006
High school	35 (36)	47 (48)		33 (39)	30 (35)	
>High school	43 (44)	28 (29)		40 (47)	31 (37)	

Abbreviations: ELBW, extremely low birth weight; NBW, normal birth weight.  
\*Young adults still in school were excluded.

**Table 4.** Current Employment and School Status by Sex of All ELBW and NBW Young Adult Participants

	No. of Participants (%)									Canadian Population Norms, %*
	Male			Female			Total			
	ELBW	NBW	P Value	ELBW	NBW	P Value	ELBW	NBW	P Value	
<b>Employment/School Status of All Participants†</b>										
No. of participants	67	60		82	73		149	133		
Permanent employment‡	38 (57)	33 (55)	.17	33 (40)	43 (59)	.001	71 (48)	76 (57)	.09	41
Part-time employed and in school	10 (15)	7 (12)		10 (12)	16 (22)		20 (13)	23 (17)		
Not employed and in school	5 (7)	12 (20)		14 (17)	2 (3)		19 (13)	14 (11)		
Not employed and not in school	14 (21)	8 (13)		25 (30)	12 (16)		39 (26)	20 (15)		14
<b>Only Permanently Employed Participants</b>										
No. of participants	38	33		33	43		71	76		
<b>Hours of work  </b>										
Full-time (≥30 h)	33 (87)	31 (94)	.31	26 (79)	33 (77)	.83	59 (83)	64 (84)	.85	83
Part-time (<30 h)	5 (13)	2 (6)		7 (21)	10 (23)		12 (17)	12 (16)		
<b>Job classification¶</b>										
Unskilled, semi-skilled	24 (63)	16 (49)	.18	13 (39)	14 (33)	.79	37 (52)	30 (40)	.25	NA
Skilled, technical, clerical	12 (32)	11 (33)		13 (39)	20 (47)		25 (35)	31 (41)		
Management, professional	2 (5)	6 (18)		7 (21)	9 (21)		9 (13)	15 (20)		

Abbreviations: ELBW, extremely low birth weight; NA, not available; NBW, normal birth weight.  
\*From the Youth in Transition Survey reports (1979-1981 births).<sup>6,7</sup> The mean age of the cohort was 22 years.  
†When neurosensory impairments were excluded,  $P = .10$ . Two-way analysis of variance, interaction between group and sex,  $P = .01$  by Holm's correction.  
‡Three permanently employed ELBW participants were in sheltered workshops.  
§In school, regardless of employment.  
||The main reason for part-time work was no full-time work was available. When neurosensory impairments were excluded,  $P = .99$ .  
¶When neurosensory impairments were excluded,  $P = .09$ .

**Table 5.** Independent Living, Marital Status, and Parenthood by Sex of All ELBW and NBW Young Adult Participants

	No. of Participants (%)									Canadian Population Norms, %*
	Male			Female			Total			
	ELBW (n = 67)	NBW (n = 60)	P Value	ELBW (n = 82)	NBW (n = 73)	P Value	ELBW (n = 149)	NBW (n = 133)	P Value	
Current living arrangements†										
Parental home‡	42 (63)	27 (45)	.04	44 (54)	36 (49)	.26	86 (58)	63 (47)	.19	58
Independent living	25 (37)	33 (55)		38 (46)	37 (51)		63 (42)	70 (53)		NA
Marital status§										
Single, never married	56 (84)	46 (77)	.14	59 (72)	54 (74)	.87	115 (77)	100 (75)	.33	80
Married	5 (7)	2 (3)		10 (12)	7 (10)		15 (10)	9 (7)		20
Unmarried, living with partner	6 (9)	12 (20)		3 (16)	12 (16)		19 (13)	24 (18)		
Parenthood	7 (10)	6 (10)	.93	9 (11)	13 (18)	.22	16 (11)	19 (14)	.36	6¶

Abbreviations: ELBW, extremely low birth weight; NA, not available; NBW, normal birth weight.  
 \*From *Statistics Canada* (2001).<sup>10</sup> Age of the cohort was 20 to 24 years.  
 †When neurosensory impairments were excluded,  $P = .14$ . Two-way analysis of variance, interaction between group and sex,  $P = .68$ .  
 ‡Included special nonindependent living arrangements (3 ELBW participants in group homes and 1 ELBW participant in assisted-living apartment).  
 §When neurosensory impairments were excluded,  $P = .28$ .  
 ||When neurosensory impairments were excluded,  $P = .51$ .  
 ¶Includes females only.

Holm’s correction; OR, 2.00; 95% CI, 1.70-2.30). Of these participants, a larger proportion of ELBW compared with NBW participants were not employed due to chronic illness or permanent disability (46% vs 15%,  $P = .03$ ). This difference was not entirely accounted for by neurosensory impairments and included some ELBW participants with mental health issues. The observed differences in unemployment did not persist when participants with impairments were excluded. Among female participants, a higher proportion of ELBW participants were neither employed nor in school (25 [30%] vs 12 [16%],  $P = .04$ ; OR, 2.22; 95% CI, 1.82-2.62).

**Living Arrangements, Marriage, and Parenthood**

No differences were observed for overall living arrangements between ELBW and NBW participants ( $P = .19$ ) (TABLE 5). The proportion of participants who were still living in the parental home was 58% for ELBW participants, 47% for NBW participants, and 58% for the Canadian population norms (aged 20-24 years)<sup>10</sup>; 4 ELBW participants with disabilities were living in group homes or assisted-living apartments. The 2-way analysis of variance interaction among living arrangements, group, and sex was not significant

( $P = .68$ ). There were no significant differences overall and by sex between ELBW and NBW participants in marital status (married or cohabitating, 34 [23%] vs 33 [25%];  $P = .69$ ). The majority of ELBW and NBW young adults were single or never married (115 [77%] vs 100 [75%],  $P = .69$ ; and 80% for Canadian population norms),<sup>10</sup> and a minority were parents in both groups (16 [11%] vs 19 [14%],  $P = .36$ ). Canadian population norms for parenthood was available only for females (6%).<sup>10</sup>

No significant differences were observed in the mean age at which the transition markers were achieved. The mean (SD) age at completion of education of those participants not currently in school was 20.1 (2.2) years in the ELBW group and 20.5 (2.1) years in the NBW group ( $P = .22$ ; mean difference,  $-0.38$ ; 95% CI,  $-0.99$  to  $0.24$ ). Among the permanently employed, the mean (SD) age of first employment was 21.5 (1.9) vs 22.0 (2.0) years ( $P = .16$ ; mean difference,  $-0.45$ ; 95% CI,  $-1.10$  to  $0.19$ ). The mean (SD) age at which the ELBW and NBW participants first left the parental home was 19.6 (2.3) vs 19.3 (2.5) years ( $P = .51$ ; mean difference,  $0.27$ ; 95% CI,  $-0.54$  to  $1.10$ ). The mean (SD) age at which the participants were first married/cohabitating

was similar (21.8 [1.9] vs 21.8 [2.3] years;  $P = .95$ ; mean difference,  $0.002$ ; 95% CI,  $-0.99$  to  $1.00$ ). No differences were observed in mean (SD) age of first-time parenthood (20.4 [2.2] vs 20.6 [2.5] years,  $P = .75$ ; mean difference,  $-0.26$ ; 95% CI,  $-1.80$  to  $1.30$ ).

**COMMENT**

Generally, the process of transition to adulthood for individuals with disabilities is considerably delayed because of physical and emotional problems, educational disadvantages, fewer opportunities, and the lack of acceptance by peers and employers.<sup>36-38</sup> Thus, at a time when most parents are anticipating a greater freedom from child care responsibilities, parents of young adults with disabilities express concern regarding the long-term outlook for the physical and mental development, educational and work prospects, and the ability of their children to achieve independence.<sup>37-40</sup> However, contrary to our hypotheses and much of the literature, we have shown that a significant majority of our ELBW participants have made a fairly successful transition from adolescence to adulthood. This general finding holds even though we included all ELBW participants with disabilities, including those for whom proxy responses were obtained. Within the ELBW cohort, a substantial proportion

portion of young adults with disabilities managed to complete high school, were enrolled in university education, lived independently, and were employed. Even with their education not yet completed, the educational attainment of the majority of ELBW young adults was equal to that of their parents. Considering that 25% or more of the ELBW participants had disabilities, this is indeed a significant achievement and attests to the remarkable resilience of the study participants. These findings do not support the predictions by Walther et al<sup>41</sup> and the fears of parents<sup>40</sup> that nearly half of the VLBW graduates from the early era of neonatal intensive care would be unable to become fully independent adults.

However, some differences in markers of academic achievement were lower in ELBW young adults, such as a lower proportion with advanced high school certificate and university enrollment or graduation. As in other studies,<sup>23,27</sup> VLBW male participants did less well academically than VLBW female participants. A small proportion (<4%) of ELBW participants with disabilities required supervised employment in sheltered workshops and were living in group homes.

The adult roles and responsibilities assumed by our study participants have to be viewed in the context of current industrialized society. The studies by Arnett<sup>1,2</sup> proposed the term *emerging adulthood*, a new conception of development for the period from the late teenage years through early 20s (18-25 years). It is distinct from both adolescence and young adulthood in that, although emerging adults may have shed dependency, they have not yet assumed the normative traditional roles attributed to adulthood, thus leading to a sort of prolonged adolescence. Between 1960 and 1993, the median age of marriage in the United States increased by 4 years.<sup>42</sup> Both marriage and parenthood are now delayed to mid-to-late 20s in North America.<sup>10,42</sup> In parallel, the period of education lasts longer with a higher

proportion of young people obtaining at least some college or university education.<sup>43</sup> Our study participants are still at a relatively young age to have completed a full transition to all of the above expected normative social roles. Nevertheless, compared with the NBW cohorts, they were achieving these markers at the same age.

Among the few articles on VLBW survivors as young adults, the most notable is the study by Hack et al,<sup>23</sup> which describes a large cohort of 20-year-old inner-city VLBW survivors from Cleveland compared with NBW peers. A significantly lower proportion of VLBW young adults had graduated from high school (74% vs 83%,  $P=.04$ ), and fewer VLBW male participants compared with female participants were enrolled in postsecondary education (30% vs 53%,  $P=.002$ ). The study by Cooke<sup>27</sup> performed a postal survey of a hospital-based cohort of 19- to 22-year-old VLBW survivors and an NBW comparison group attending mainstream schools in Liverpool, England. A higher proportion of VLBW young adults compared with NBW young adults had vocational qualifications (54% vs 23%, respectively;  $P<.001$ ), fewer were at university or had completed a degree (23% vs 58%,  $P<.001$ ), and a higher proportion were in paid employment (44% vs 27%;  $P<.05$ ). A major limitation of this study was that only 57% and 44%, respectively, of VLBW and NBW young adults participated.

Some differences between our findings and those by Hack et al<sup>23</sup> merit further comment. Compared with our cohort, the participants in the study by Hack et al were more mature at birth (27.1 vs 29.7 weeks) and fewer had neurosensory impairments (27% vs 10%). However, the 2 populations were very different. The Cleveland cohort<sup>23</sup> was 55% black and 41% were from socioeconomically disadvantaged single-parent families. Thus, despite the greater immaturity of our cohort, a higher proportion graduated from high school (82% vs 74%). In fact, the proportion of our ELBW young adults who graduated from high school

was similar to the Cleveland NBW cohort.<sup>23</sup>

Although there is no doubt that ELBW children are at high risk of incurring substantial neurological deficit, and that those children with such damage have poor outcomes regardless of the age at assessment, the future of those children with more subtle deficits must be considered from a lifespan perspective, as recovery may not be evident until adulthood.<sup>44</sup> The few studies of young adults who were born preterm seem to suggest that some recovery of function does occur, in that the participants were doing better than predicted in their health, behavior, and social and emotional functioning; however, the samples in the literature are not equivalent with respect to degree of immaturity, birth weight, race, and socioeconomic status.<sup>23-27</sup> Important proximal sources of influence on early child development, such as parental disharmony, the quality of infant-mother attachment, the child's temperament, and social support and mentoring,<sup>5,45</sup> need to be evaluated in preterm populations. The longitudinal study from birth to mid-life of socially disadvantaged children born on the island of Kauai by Werner and Smith<sup>46</sup> has significantly advanced the concepts of vulnerability and resilience, and of protective factors that allow vulnerable children to overcome biological and social, family, and environmental adversity to become competent and caring adults. Whether these concepts apply to preterm populations, with their greater biological risk, remains to be determined.

Against our expectations and many odds, a significant majority of ELBW young adults have overcome earlier difficulties to become functional members of society. It is not clear what factors contributed to the positive outcome beyond adolescence, as all through childhood the ELBW cohort was significantly compromised in comparison with their peers.<sup>12,16</sup> Our study participants were predominantly white and from a relatively advantaged, homogeneous

population. Regional intensive care was well-established during this period<sup>30</sup> and all participants had access to universal health care through provincial-based insurance systems. Children with disabilities were integrated into regular schools and were provided teaching assistants, and home and workplace accommodations were made by the Canadian society for persons with disabilities. Our data are, therefore, only generalizable to populations with similar sociodemographics and living in similar environments from the era of the 1980s, and perhaps the 1990s.

Whether our findings are relevant to the young adults of today who weighed less than 1000 g at birth is a more difficult question. Recent studies show that there is little, if any, improvement in the last 30 years in the prevalence of neurodevelopmental disabilities in infancy<sup>47-49</sup> or school performance in mid-childhood.<sup>19,20</sup> Current ELBW survivors, however, are more immature in gestational age and it is feared that they may have even poorer outcomes.<sup>47-49</sup> It is possible, however, that with some of the advantages of access to modern neonatal intensive care, better nutrition, and early infant intervention, the outcomes to early childhood of ELBW young adults born in this century will be more favorable than that reported in recent studies,<sup>13,14,49</sup> and may improve further over time. Our study should provide hope to parents for an equivalent, if not a better, future for their premature children in the longer term. Ongoing studies from research centers with established cohorts from the recent era are warranted.

**Author Contributions:** Dr Saigal had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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**Drafting of the manuscript:** Saigal, Stoskopf, Paneth.  
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Why abandon a belief merely because it ceases to be true? Cling to it long enough and . . . it will turn true again, for so it goes. Most of the change we think we see in life is due to truths being in and out of favor.  
—Robert Frost (1874-1963)