

Milestones in the Process of Cessation Among Novice Adolescent Smokers

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Cigarette use remains common among young people, in part because little is known about how to help adolescent smokers quit. Recent reviews show limited evidence for the efficacy of either behavioral or pharmacological cessation interventions among adolescents.^{1,2} Many adolescent smokers want to quit and try to do so, but most are unsuccessful. A review of 52 studies of current adolescent smokers found that the median prevalence of cessation attempts after 6 months of smoking was 58%; after 1 year, 68%; and lifetime, 71%.³ More than half had made multiple quit attempts. Among those who attempted cessation, the median prevalence of relapse after their longest attempt was 34% in 1 week, 56% in 1 month, 89% in 6 months, and 92% in 1 year.

Increasing evidence indicates that the first puff on a cigarette begins a process that rapidly leads to symptoms of nicotine dependence and escalating cigarette use in many novice smokers.⁴ Young people may need help with cessation soon after initiating cigarette use to manage nicotine dependence symptoms and enable successful quitting.

Numerous theoretical models describe the acquisition of smoking in adolescents, usually by stages,⁵⁻⁷ but few elaborate the process of cessation. Researchers often characterize cessation as a discrete event rather than as a process, despite evidence that sustained cessation, at least among adults, often requires repeated attempts.⁸ Although adolescents in the early stages of smoking onset alternate between periods of smoking and abstinence,^{9,10} it is not clear whether the periods of abstinence represent the exercise of free will¹¹ or serious attempts to quit that are impeded by nicotine dependence symptoms.

Few studies document the sequence and timing of specific events or milestones that may be important in the process of cessation. Increased understanding of the early milestones in the process of cessation in novice adolescent smokers may identify theoretical underpinnings that support the development of effective

Objectives. We sought to document the sequence and timing of milestones in the process of smoking cessation by prospectively studied cessation milestones among novice adolescent smokers.

Methods. Participants, aged 12 to 13 years in 1999 (n=1293), completed self-report questionnaires every 3 months during the school year over 5 years. We ascertained time after first puff to attain 5 cessation milestones among 319 participants who initiated cigarette smoking during follow-up.

Results. The cumulative probability of first reports of a serious desire to quit and perceived permanent cessation was 25% at 1.5 months (95% confidence interval [CI]=1.5, 2.5) after the first puff. The first serious quit attempt occurred at 2.5 months (95% CI=2.5, 5.4), lack of confidence about quitting followed at 18.4 months (95% CI=18.4, 26.8), and awareness of the difficulty of quitting occurred at 32.2 months (95% CI=19.2, 38.4).

Conclusions. Desire and attempts to quit began soon after smoking onset. Novice smokers progressed through several stages in their perception of the difficulty of quitting. Increased understanding of the cessation process may help in developing effective tobacco control interventions for novice smokers. (*Am J Public Health.* 2009;99:499-504. doi:10.2105/AJPH.2007.128629)

tobacco control interventions for young people. We sought to describe the sequence and timing of cessation milestones among novice adolescent smokers in relation to the onset of cigarette smoking and the development of nicotine dependence symptoms.

METHODS

We used data from the Nicotine Dependence in Teens study, a prospective investigation of 1293 students, recruited from among all grade 7 classes in a convenience sample of 10 Montreal-area (Quebec) secondary schools.¹² Baseline data were collected in self-report questionnaires in the fall of 1999, and follow-up data were collected over the next 5 years, at 3-month intervals during the 10-month school year. Approximately half (55.4%) of eligible students participated at baseline. Nonparticipation was attributable to student reluctance to participate in blood sampling (for genotyping) and to a provincial labor dispute that resulted in some teachers refusing to collect consent forms.

Our analysis included only those participants who reported that they had never smoked at

baseline and who initiated cigarette smoking in any of the 19 follow-up survey cycles. We used data on lifetime smoking to identify never smokers at baseline who initiated cigarette smoking during follow-up. Lifetime smoking was measured in each survey cycle with the question, "Have you ever IN YOUR LIFE smoked a cigarette, even just a puff (drag, hit, haul)?" Possible answers were no; yes, 1 or 2 times; yes, 3 or 4 times; yes, 5 to 10 times; and yes, more than 10 times. Among 1293 students who participated in the baseline data collection, 814 had never smoked. Of these, 360 (44%) initiated smoking during follow-up, as measured by any affirmative response to the lifetime smoking question.

Time of the first puff was determined by a 3-month recall of cigarette use completed in each survey cycle. Participants reported on cigarette smoking in each of the past 3 months in each questionnaire, including the number of days on which they had smoked during the month and the average number of cigarettes smoked per day during that month. Three-month test-retest reliability for these 2 items was good ($\kappa=0.78$ and 0.75 , respectively).¹³

For 258 of 360 initiators identified, time (i.e., day, month, and year) of the first puff was designated as the midpoint of the month during which the respondent first reported smoking cigarettes in the 3-month recall. Some initiators did not report smoking cigarettes in the 3-month recall but reported lifetime use; we designated the time of their first puff as the date of completion of the questionnaire in which they first reported lifetime use ($n=25$). For other initiators, who did not report smoking in the 3-month recall but gave a positive answer to a smoking status question, we used the midpoint of the year preceding that answer ($n=36$). In that item, participants were asked to check the most accurate description among “I have never smoked a cigarette, even just a puff”; “I have smoked cigarettes, even just a puff, but not at all in the past 12 months”; “I smoked cigarettes once or a couple of times in the past 12 months”; “I smoke cigarettes once or a couple of times each month”; “I smoke cigarettes once or a couple of times each week”; and “I smoke cigarettes every day.” Forty-one initiators were excluded from the analysis because the time of the first puff could not be determined; thus, our analysis included 319 initiators.

Milestones

At each survey cycle following initiation, attainment of 15 milestones related to smoking cessation, increasing cigarette use, and nicotine dependence was assessed. We recorded the survey date on which participants first reported 5 cessation-related milestones:

1. Perceived complete cessation, when the participant responded yes to, “Would you say that you are someone who has tried smoking cigarettes but has now stopped smoking completely and (probably) forever?” The other response choices were no and don’t know.
2. Awareness of the difficulty of quitting, when the participant responded sometimes, often, or always to, “Do you smoke now because it is really hard to quit?” The other response choices were no and I don’t know.
3. Serious desire to quit, when the participant responded a little bit, quite a bit, or a whole lot to, “At this point in time, how much do you really want to quit smoking

cigarettes completely and forever?” The other response choice was not at all.

4. Serious quit attempt, when a positive response was given to, “In the past 3 months, did you seriously try to quit smoking completely and forever?”
5. Lack of confidence about quitting, when the participant responded not very or not at all to, “How confident are you right now that you can or you have quit smoking completely and forever?” The other response choices were very and fairly confident.

We recorded the survey date when participants first reported 6 milestones related to cigarette use:

1. First inhalation, ever taking cigarette smoke into the lungs.
2. First whole cigarette, ever smoking a whole cigarette (down to or close to the filter).
3. Monthly smoking, when the response “I smoke cigarettes once or a couple of times each month” was given in the smoking status item.
4. Weekly smoking, when the response “I smoke cigarettes once or a couple of times each week” was given in the smoking status item.
5. Daily smoking, when the response “I smoke cigarettes every day” was given in the smoking status item.
6. Lifetime consumption of 100 cigarettes, when a positive response was given to, “Have you smoked 100 or more whole cigarettes in your life? (100 cigarettes=4 packs of 25).”

We also recorded the survey date on which participants who reported smoking cigarettes in the past 3 months first reported 4 milestones measuring dependence symptoms:

1. Tolerance, when the response a bit true or very true was given to, “Compared to when I first started smoking, I can smoke much more now before I start to feel nauseated or ill.” The other response choice was not at all true.
2. Cravings, when a positive response was given to, “Do you ever have cravings to smoke cigarettes?”
3. Withdrawal symptoms, when the response rarely, sometimes, or often was given to, “Now think about the times when you have

cut down or stopped using cigarettes or when you haven’t been able to smoke for a long period (like most of the day). How often did you experience feeling a strong urge or need to smoke?” The other response choice was never.

4. Conversion to tobacco dependence as defined by the *International Classification of Diseases, 10th Revision (ICD-10)*,¹⁴ when the respondent met 3 or more of the 6 *ICD-10* criteria for tobacco dependence.¹⁵ The development and psychometric properties of our measure of *ICD-10* tobacco dependence for adolescents are described elsewhere.¹⁶

Data Analysis

We measured the cessation process among the 319 initiators by the cumulative probability of attaining each milestone according to the time in months from smoking initiation (the first puff). Probabilities were computed with Kaplan-Meier analysis, which is the method of choice when the length of follow-up differs between respondents and when censoring occurs (i.e., when a participant is lost to follow-up or reaches the end of the study without having experienced the milestone). The Kaplan-Meier curve is interpreted as the cumulative probability that the milestone of interest has occurred by a particular time.

We reported the time in months when the cumulative probability of attaining each milestone was 25%, because 25% or more of initiators attained all the milestones investigated. We repeated this analysis in 3 subgroups of initiators: (1) 258 respondents who inhaled, (2) 220 respondents who smoked a whole cigarette, and (3) 144 respondents who had experienced cravings. We hypothesized that the temporal sequence of and time interval between cessation milestones might differ in these subgroups.

RESULTS

Among the 319 initiators included in the analysis, the median length of follow-up from the baseline data collection was 54 months (range=5–56 months), and the median length of follow-up from the first puff was 32 months (range=0–54 months). The characteristics of

the 41 initiators excluded from the analysis were similar to those of the 319 included (Table 1). At 48 months after baseline, 54 of the 319 initiators (17%) had not smoked in the past 12 or more months (censored respondents were assumed to have continued smoking); this group may represent respondents who quit smoking permanently.

Incidence Rate for Cessation Milestones

Table 2 shows the incidence rates at which initiators attained each of the 5 cessation-related milestones, in relation to the incidence rates for the milestones related to smoking onset and nicotine dependence symptoms. Among cessation-related milestones, the incidence rate for self-reported permanent cessation was highest (82 per 1000 person-months), followed by a serious desire to quit (70 per 1000 person-months). The incidence rates per 1000 person-months for serious quit attempts (28), lack of confidence about quitting (13), and awareness of the difficulty of quitting (10) were notably lower.

The incidence rates for the first 3 cessation milestones were notably higher among girls

than boys, although the confidence intervals for perceived permanent cessation overlapped. However, there was little difference by gender in the incidence rates for later milestones, including lack of confidence about quitting and awareness of the difficulty of quitting.

Temporal Sequence and Time Interval Between Milestones

Figure 1 shows the cumulative probability of attaining each milestone according to the number of months since the first puff. The indicators for the complete cessation and serious desire to quit milestones mirrored the curves for the first inhalation and first smoking a whole cigarette. These curves generally increased rapidly for 12 months after the first puff and then leveled off. By 48 months after the first puff, 86% and 83% of initiators, respectively, had attained each of these 2 cessation milestones.

The cumulative probability of a serious quit attempt was tightly aligned with the curve for cravings, increasing rapidly for 12 months and then increasing more slowly thereafter; at 48 months, 60% of new initiators had seriously

tried to quit. The curves showing the cumulative probabilities of lack of confidence about quitting and awareness of the difficulty of quitting increased steadily over time after the first puff. At 48 months, approximately 42% of initiators lacked confidence that they could quit, and 33% were aware of the difficulty of quitting. The curve for lack of confidence about quitting was aligned with the curves for weekly smoking and lifetime consumption of 100 cigarettes. The curve for awareness of the difficulty of quitting was aligned with the curve for daily smoking.

We estimated the number of months after the first puff when the cumulative probability of attaining each milestone was 25% (Figure 2). As previously reported,⁴ inhalation and smoking a whole cigarette occurred rapidly within 1 to 2 months of initiation; it took almost 9 months to attain monthly smoking, 20 months to attain weekly smoking and a lifetime total of 100 cigarettes, and 24 months to attain daily smoking. Among milestones related to nicotine dependence, cravings appeared rapidly, 5 months after initiation. Withdrawal symptoms and tolerance took 12 to 14 months, and conversion to *ICD-10* tobacco dependence took 46 months.

Three of the 5 cessation-related milestones occurred within 2.5 months of the first puff. The cumulative probability of perceived permanent cessation and a serious desire to quit was 25% within 1.5 months of initiation. A first serious quit attempt was reported at 2.5 months. By contrast, lack of confidence about quitting occurred at 21 months after initiation, many months after initial serious attempts at quitting. Finally, awareness of the difficulty of quitting occurred relatively late in the process, at 32 months.

The probability of attaining each cessation milestone was higher in each subgroup than among all initiators, and this was most significant among participants who reported cravings. For example, the cumulative probability of a strong desire to quit among those who had experienced cravings was 80% at time 0 (when cravings were first reported) and almost 100% by 48 months. (Tables showing details of cessation history among subgroups of participants who had inhaled into their lungs [n=258], smoked a whole cigarette [n=220], and experienced cravings [n=144] are available as

TABLE 1—Selected Characteristics of Adolescent Smokers Retained and Excluded in an Analysis of Smoking Cessation Milestones: Nicotine Dependence in Teens Study, 1999–2005

	Retained (n=319), % or Mean (SD)	Excluded ^a (n=41), % or Mean (SD)	P
Age, y	12.7 (0.4)	12.7 (0.5)	.406
Male	42.6	48.8	.455
Language			.206
English	61.0	56.1	
French	23.0	17.1	
English and French	16.0	26.8	
Single-parent family	8.5	9.8	.781
No. of siblings	1.7 (1.3)	1.9 (1.5)	.434
Entire life spent in Canada	93.1	90.2	.513
Family			
Father smokes	21.6	24.4	.902
Mother smokes	18.5	19.5	.982
≥1 Brothers smoke	6.6	12.2	.191
≥1 Sisters smoke	6.3	2.4	.325
Friends smoke	27.6	26.8	.919
Mother's education			.747
Less than university	48.0	53.7	
University	39.2	36.6	
Missing	12.9	9.8	

^aIncludes participants who initiated tobacco use during follow-up but were excluded from subsequent analysis because time of the first puff could not be determined.

TABLE 2—Incidence Rate for Milestones in Cigarette Use and Smoking Cessation: Nicotine Dependence in Teens Study, 1999–2005

Milestones	All (n = 319)			Adolescent Boys (n = 136)			Adolescent Girls (n = 183)		
	Attained milestone, No.	Person-months of follow-up	IR (95% CI)	Attained milestone, No.	Person-months of follow-up	IR (95% CI)	Attained milestone, No.	Person-months of follow-up	IR (95% CI)
First inhalation	258	2576	100 (78, 113)	100	1227	81 (66, 99)	158	1349	117 (99, 137)
Perceived permanent cessation	246	3011	82 (72, 93)	98	1321	74 (59, 90)	148	1690	88 (74, 103)
Serious desire to quit	230	3296	70 (61, 79)	80	1711	47 (37, 58)	150	1585	95 (80, 111)
First whole cigarette	220	3957	56 (49, 63)	81	1809	45 (35, 56)	139	2149	65 (54, 76)
Serious quit attempt	154	5501	28 (24, 33)	52	2488	21 (16, 27)	102	3013	34 (28, 41)
Cravings	144	5660	25 (21, 30)	42	2678	16 (11, 21)	102	2983	34 (28, 42)
Monthly smoking	127	6481	20 (16, 23)	41	2684	15 (11, 21)	86	3797	23 (18, 28)
Withdrawal symptoms	116	6614	18 (15, 21)	38	2833	13 (10, 18)	78	3781	21 (16, 26)
Tolerance	114	6801	17 (14, 20)	31	2987	10 (7, 15)	83	3814	22 (17, 27)
Lifetime consumption of 100 cigarettes	100	7352	14 (11, 17)	37	2880	13 (9, 18)	63	4472	14 (11, 18)
Lack of confidence about quitting	95	7471	13 (10, 16)	32	3024	11 (7, 15)	63	4447	14 (11, 18)
Weekly smoking	88	7450	12 (10, 14)	28	3028	9 (6, 13)	60	4422	14 (10, 17)
Daily smoking	83	7751	11 (9, 13)	34	2987	11 (8, 16)	49	4764	10 (8, 14)
Awareness of difficulty of quitting	75	7618	10 (8, 12)	23	3102	7 (5, 11)	52	4516	12 (9, 15)
Tobacco dependence ^a	55	8155	7 (5, 9)	22	3100	7 (5, 11)	33	5055	7 (5, 9)

Note. IR = incidence rate; CI = confidence interval. The IR was defined as the number of participants who attained each milestone per 1000 person-months during the 1999 to 2006 follow-up. The 95% CIs were computed on the basis of Poisson distribution.

^aAs defined by the *International Classification of Diseases, 10th Revision*.¹⁴

supplements to the online version of this article at <http://www.ajph.org>)

DISCUSSION

Our results document the sequence and timing of early milestones in the process of

cessation among novice smokers. The data suggest that for novice smokers, cessation may be understood as a progression of phases. The first phase occurs 1 to 2 months after the first puff, as young smokers increase exposure to nicotine through inhalation and smoking a first whole cigarette. It is characterized by naive

certainty about the ability to quit, when young smokers confidently declare that they have stopped smoking completely and probably forever. This is followed rapidly by expression of a conscious desire to quit and the growing realization that quitting requires serious effort. Over the next 2 years, as cravings, withdrawal

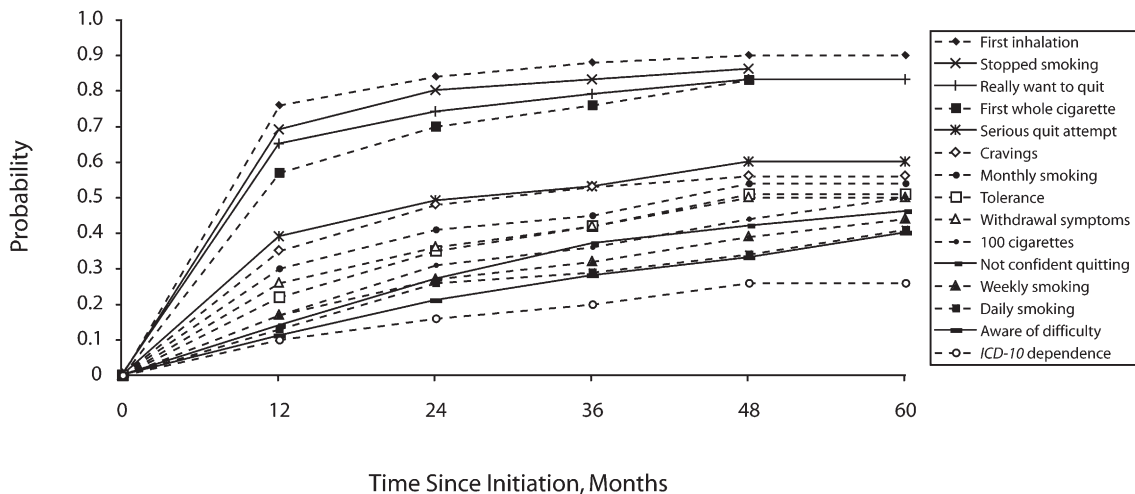
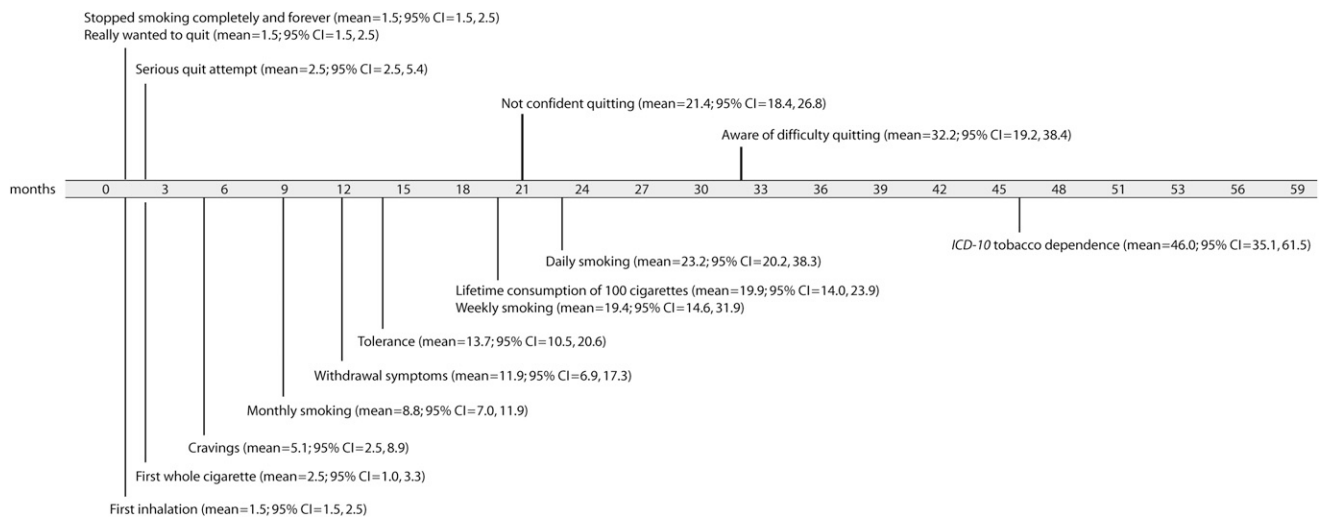


FIGURE 1—Cumulative probability of attaining cessation milestones since smoking initiation (n = 319): Nicotine Dependence in Teens Study, 1999–2005.



Note. CI = confidence interval. Mean is the mean number of months.

FIGURE 2—Number of months after initiation at which the probability of attaining each milestone was 25%: Nicotine Dependence in Teens Study, 1999–2005.

symptoms, and tolerance emerge, and as smoking escalates to monthly cigarette use, novice smokers gradually lose confidence in their ability to quit. Approximately 1 year after reporting loss of confidence and after escalation to daily smoking, these young smokers come to the realization that they smoke now because it is very hard to quit. Full-blown tobacco dependence manifests approximately 14 months thereafter.

Subgroup analyses suggested that progression to cessation milestones was more rapid once milestones in the onset process—inhalation, smoking a whole cigarette, and experiencing cravings—were reported. Although follow-up of this cohort after the first puff was relatively short (median=32 months), only 19% had stopped smoking for 12 or more consecutive months at the end of the study.

Several features of this cessation process should be considered in the design of tobacco control interventions targeted to youths. First, several cessation milestones, including a serious desire to quit and a serious quit attempt, occurred very early after the first puff, suggesting that adolescents may well be receptive to cessation interventions soon after they begin smoking. Second, although novice smokers expressed certainty that they had quit early in the cessation process, the data showed that many simply could not or did not stop smoking,

so that this certainty was apparently naive.

Third, despite escalating cigarette use and the emergence of nicotine dependence symptoms, it took novice smokers almost 2 years before they lost confidence in their ability to quit and almost 3 years before they admitted that they smoked because they could not quit. Fourth, although 230 of 319 novice smokers expressed a desire to quit, only one fifth had abstained for 12 or more months by the end of the follow-up period. This underscores an important disconnect between expressed desire to quit and ability to do so, even among young newly initiated smokers.

Overall these data suggest that interventions may be needed to educate novice smokers (and others) that a first puff can represent the beginning of a process that leads rapidly to escalating cigarette use, emergence of nicotine dependence symptoms, and loss of control over smoking. Behavioral or pharmacological tobacco control interventions that take milestones in the process of smoking onset and cessation into account may be needed soon after the first puff in some adolescents.

Our study had several limitations. We studied novice smokers during secondary school, and the process of cessation may differ in those who initiate smoking earlier or later in life. In addition, data were based on self-reports, which may result in under- or

overestimation of the time to attain cessation-related milestones. Finally, follow-up was only 5 years. Longer follow-up is needed to better understand how these milestones relate to continued smoking or successful quitting.

The desire to quit and attempts to quit began very early after the onset of cigarette smoking among adolescents in our study. As cigarette use increased and nicotine dependence symptoms developed, novice smokers progressed from naive certainty about their ability to quit to growing awareness of the difficulty of quitting, loss of confidence in their ability to quit, and finally awareness that they could not quit.

Young people, their parents, and health professionals must be made aware that cessation among novice smokers is problematic, even in the early stages of the smoking-onset process. Furthermore, as the process intensifies and nicotine dependence emerges, cessation may become increasingly difficult. Despite early and increasing difficulty in quitting, it took almost 3 years after the first puff before novice smokers in our study realized that they could not quit of their own free will. Tobacco control interventions that manage escalating cigarette use and nicotine dependence symptoms may be needed soon after the first puff in some novice adolescent smokers. ■

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Contributors

J. O'Loughlin designed the study, obtained the funding, developed the survey instruments, supervised data collection, contributed to the analysis and interpretation of data, and wrote the article. A. Gervais contributed to the analysis and interpretation of data and wrote sections of the article. E. Dugas reviewed the literature and contributed to writing the article. G. Meshefedian performed data analysis and contributed to data interpretation. All authors reviewed the article critically for important intellectual content and approved the final version.

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Human Participant Protection

The study was approved by the institutional review board of the McGill University Faculty of Medicine, Montreal, Quebec. Parents of participants provided written informed consent and participants provided assent.

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