



Prevention of Overweight and Obesity in Young Canadian Children

A CCFN WATCHING BRIEF

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The prevalence of excess weight is increasing among young children in developed and developing countries. In Canada, 15.2% of 2–5 year olds are overweight and 6.3% are obese, according to International Obesity Task Force criteria for overweight and obesity among children. If current trends continue, 46% of school-aged children in the Americas will be overweight or obese by 2010, as the current generation of preschoolers enters school.

Although childhood obesity puts children at significant risk for many health problems, scientists suggest that the greatest health problems will be seen as the present generation of overweight and obese children becomes the next generation of adults. Insofar as childhood obesity persists (or “tracks”) into adulthood, higher rates of obesity-related disease are predicted to emerge in younger adults, who may require access to specialized healthcare throughout their remaining lifetimes.

Canadian survey data for children aged 0–6 years are lacking, and therefore it is not possible to fully characterize the dietary and physical activity patterns of young children, or to assess how changes in these patterns may have contributed to the current epidemic of obesity.

Although interventions that target the eating, activity and sleep patterns of young children are limited, results suggest that these types of interventions may be efficacious. Additional research is needed in this area, and future studies should focus on parents and caregivers as agents of change.

Obesity prevention is a community responsibility that is best addressed using multi-level, multi-sectoral public health strategies. Given that obesity may be programmed *in utero* and during early infancy, preventive measures should be initiated *in utero* and continue throughout early childhood.

ⁱ This Watching Brief is based on a [more extensive report, which is available to CCFN members](#).



Defining overweight and obesity in young children

The body mass index (BMI) is the most common means of defining what constitutes a healthy body weight for adults and children (Katzmarzyk et al., 2007). BMI and its associated health risks change substantially with age, however, and a high BMI during childhood is not associated with a high incidence of morbidity or mortality as it is in adults (Fox, 2004a). As a result, it is difficult to quantify levels of excessive fatness in children, and separate BMI classification systems have been developed for children and for adults (Fox, 2004a).

Two major approaches have been developed to identify children with excessive body weights based on BMI (Katzmarzyk et al., 2007). In Canada, the 85th and 95th percentiles of BMI on the US Centers for Disease Control (CDC) growth charts are used to classify children aged 2 years or older as “overweight” or “obese”, respectively (Katzmarzyk et al., 2007). Weight-for-height growth charts are used to monitor the growth of children under the age of 2, as BMI charts do not exist for infants. The second approach, endorsed by the International Obesity Task Force (IOTF), links childhood BMI cut-off points with adult overweight (BMI=25 kg/m²) and obesity (BMI=30 kg/m²) thresholds (Cole et al., 2000), and is primarily used for obesity surveillance in research settings (Katzmarzyk et al., 2007).

For the purposes of this review:

- “infant” = 0 to 12 months of age
- “toddlers” = 12 to 36 months of age
- “preschoolers” = 3 to 6 years of age

The problem of overweight and obesity among young children

Canadian rates of overweight and obesity among young children

Whereas obesity was rarely observed among children and adolescents 30 years ago, it is now evident among Canadian children of all ages (Shields, 2004). Between 1978-79 and 2004, the overall prevalence of overweight among 2–17 year olds increased from 12% to 18%, while the prevalence of obesity jumped from 3% to 8% (Shields, 2004). The rate of overweight among the subgroup of children aged 2–5 years was slightly lower at 15.2%, while 6.3% were obese (Shields, 2004). This combined rate of 21.5% remains unchanged since 1978-79 (Shields, 2004).

Adverse health effects of overweight and obesity among children

Obesity in infancy persists through the preschool years (Mei et al., 2003), and to later childhood (Quattrin et al., 2005). Childhood obesity is also an independent risk factor for adult overweight or obesity (Felton et al., 1998; Whitaker et al., 1998b), with obese children having at least a 25% to 50% increased risk of being obese as adults (Guo et al., 2000). Early childhood BMI is moderately correlated with adult adiposity (Freedman et al., 2005), and overweight 2- to 5-year-old children are more than four times as likely to become overweight as adults (Freedman et al., 2005).

Long-term prospective studies have demonstrated eight diseases to be definitively associated with obesity: coronary artery disease, stroke, hypertension, colon cancer, postmenopausal breast cancer, type 2 diabetes, gall bladder disease, and osteoarthritis



(Katzmarzyk and Janssen, 2004). Although clinical evidence of disease is often absent in children, traditional and non-traditional risk factors emerge early in the course of obesity and establish a pervasive environment for the development of premature health problems including pulmonary, orthopaedic, gastroenterologic, neurologic, cardiovascular, and endocrine conditions (Lobstein et al., 2004; Dietz, 1998; Visser et al., 2001; Kelly et al., 2004; Balagopal et al., 2005; Monzavi et al., 2006). Overweight children are more likely than non-overweight children to exhibit risk factors for chronic disease such as hyperlipidemia, low HDL cholesterol, hypertension, and hyperinsulinemia (Morrison et al., 1999a, 1999b; Freedman et al., 1999; Chu et al., 1998; Csabi et al., 2000), and these risk factors may track from childhood into adulthood (Lobstein et al., 2004).

Risk factors are distinct from clinical disease, and until recently overt disease was rare among children (Lobstein et al., 2004). The physical consequences of childhood obesity are, however, increasingly leading to overt disease in childhood (Lobstein et al., 2004). Previously seen only in adults, type 2 diabetes and the metabolic syndrome have emerged among children as a direct consequence of rising obesity rates (Lobstein et al., 2004; Csabi et al., 2000; Weiss et al., 2004). The development of chronic disease may therefore be a long process that originates in childhood (Csabi et al., 2000).

Beyond its adverse effects on the physical health of children, the most immediate consequences of childhood obesity may be in terms of adverse social and psychological health (Lobstein et al., 2004). Balagopal (2006) has suggested that the adverse psychological consequences of obesity may exacerbate its negative physical consequences, accelerating the progression to diabetes and/or cardiovascular disease in obese children. The psychosocial complications of overweight and obesity among young children have not been studied.

Change in landscape

The increased prevalence of obesity is widely regarded as an epidemic that threatens to ruin the physical and economic health of North America. If current upward trends continue linearly, the proportion of overweight and obese school-aged children in the Americas will grow to more than 46% by 2010, as the current generation of preschoolers enters school (Wang and Lobstein, 2006).

Although childhood obesity puts children at significant risk for many health problems, scientists suggest that the greatest health problems will be seen as the present generation of overweight and obese children becomes the next generation of adults (Lobstein et al., 2004). Up to 33% of adult obesity may have its origins in childhood obesity (Power et al., 1997a; Serdula et al., 1993). Insofar as childhood obesity tracks into adulthood, higher rates of obesity-related disease are predicted to emerge in younger adults, who may require access to specialized healthcare throughout their remaining lifetimes (Lobstein et al., 2004). The consequences will be evident in rapid escalation of healthcare spending, significant losses to society, and a greater health burden for individuals (Lobstein et al., 2004). Investments in childhood obesity prevention programs are likely to be quantitatively small compared to the accumulated costs associated with treating obese individuals.



Lifestyle-associated behaviours of young children

Optimal diets for young children

A healthy food intake pattern throughout life is important for obesity prevention. Healthy diets for young children begin with exclusive breastfeeding for the 6 months of life. Health Canada (2005) recommends breastfeeding for up to 2 years and beyond, with the introduction of nutrient-rich complementary solid foods at 6 months. Beginning at age 2, children should follow the recommended eating pattern outlined in “Eating Well with Canada’s Food Guide” (Health Canada, 2007). Children who follow the recommended eating pattern are more likely to meet their nutrient requirements, achieve overall health and vitality, and lower their risk of chronic disease (Health Canada, 2007).

Dietary patterns of young children

The Canadian Community Health Survey (CCHS) is the first large-scale Canadian nutrition survey to characterize the diets of children under the age of 5. For this reason, it is not possible to ascertain how changes in the consumption patterns of young Canadian children may have contributed to the current obesity crisis. However, the food consumption patterns of 4–8 year olds outlined in the CCHSⁱⁱ do suggest that dietary patterns linked to an increased risk for obesity are prevalent among young children. Notably, 71% of 4- to 8-year-old children did not meet the recommended daily minimum number of servings of vegetables and fruit, 37% did not consume 2 servings of milk products daily, and 27% did not consume sufficient grain products in a day (Garriguet, 2004). Children who consumed fewer than 5 vegetables and fruit daily were significantly more likely to be overweight or obese (Shields, 2004). Just over one quarter (26.8%) of the total daily calories of 4–8 year olds were ingested between regular meals, of which the majority was supplied by nutrient-poor, high fat, high sugar foods (Garriguet, 2004). These snacks supplied more calories than were consumed at breakfast (18%) and lunch (25.6%) (Garriguet, 2004). Furthermore, nearly one fifth of 4–8 year olds had eaten in a fast food outlet on the day before the survey (Garriguet, 2004).

Similarly disturbing trends emerged from dietary survey data collected for the Feeding Infants and Toddlers Study (FITS) in the US. According to these data, 18%–33% of infants and toddlers consumed no distinct fruit and vegetables during a day, and by 15 months, french fries were the most common vegetable in children’s diets (Fox et al., 2004). Desserts, sweets and sweetened beverages were also commonly consumed (Fox et al., 2004). Nearly half of toddlers consumed at least one meal or snack away from home (any location excluding daycare) on any given day (Ziegler et al., 2006), which is a concern because 35% of away-from-home lunches included french fries, and 30% included sugar-sweetened beverages (Ziegler et al., 2006). Indeed, intake of sugar-sweetened beverages nearly doubles from 2 to 6 years of age (Skinner and Carruth, 2001), and may displace more healthful foods and beverages such as milk (Marshall et al., 2005) and increase the risk of overweight (Troiano et al., 2000; Dubois et al., 2007). These data demonstrate that infants and toddlers are being fed the same foods as the rest of the family (Fox et al., 2004), despite their substantial need for nutrient-dense foods to support rapid growth and development. Dietary patterns commonly exhibited in older children and adult populations

ⁱⁱ CCHS data for the 1- to 3-year-old age grouping have not been released.



were evident as early as 9–11 months of age (Fox et al., 2004). Because diet quality typically declines from early childhood through to adolescence (Lytle et al., 2000; Mannino et al., 2004), these patterns may persist and worsen over time.

Little is known regarding the dietary patterns of Canadian children in childcare. No national nutrition guidelines exist for Canadian childcare facilities, whereas in the US, meals and snacks must meet federal guidelines (ADA, 2005; Fox et al., 1997). In spite of the US dietary guidelines, more than 25% of federally funded daycares in the US do not provide the recommended minimum number of daily servings of fruits and vegetables (Fox et al., 2006a, 2006b). French fries and baked potatoes are the most common vegetables provided in US daycares, while sweetened beverages represent the major source of fruit (Ziegler et al., 2006). Overall, US children in childcare consistently fail to meet food pyramid recommendations for grains and vegetables (Bruening et al., 1999; Padget and Briley, 2005; Oakley et al., 1995), indicating a need to revise and/or enforce national nutrition guidelines.

Optimal physical activity for young children

Physical activity during childhood can be depicted as a continuum. Young children begin by learning basic movement patterns that are progressively integrated into more specialized and complex movement skills as neuromuscular control develops (Strong et al., 2005). Young children should not be viewed as miniature adults, however, and the intensity, duration, frequency, and mode of physical activity recommended for adults is not appropriate for young children (NASPE, 2002). Whereas physical activity guidelines for adults are based on preventing chronic disease and unhealthy weight gain, the outcomes of physical activity for young children centre on enjoyment of movement, developing motor skill confidence and competence, and establishing the foundation for a future active lifestyle (NASPE, 2002).

A firm evidence base does not exist from which to develop physical activity guidelines for children (Rennie et al., 2006). Although it is generally agreed that physical activity is important for children, it is difficult to demonstrate a health benefit because most of the negative health outcomes of inactivity are not commonly found in children (Hills et al., 2007), and the amount of play needed for optimal motor skill development has not yet been identified (Timmons et al., 2007). Canadian and American governments have consequently not developed physical activity guidelines for young children. The National Association for Sport and Physical Education (NASPE, 2002) is the only national body in North America that has developed physical activity recommendations specific to infants, toddlers and preschoolers. The five guidelines for infants emphasize allowing them to explore their surroundings, develop movement skills, and use large muscle groups in a safe environment (NASPE, 2002). Toddlers are advised to accumulate at least 30 minutes of structured physical activity daily, and preschoolers 60 minutes per day (NASPE, 2002). Both groups should ideally accumulate a minimum of 60 minutes of unstructured physical activity, while avoiding periods of inactivity longer than 60 minutes (NASPE, 2002). Some Canadian bodies, including Alberta Health and Wellness (Healthy U Alberta, 2006), have adopted the NASPE recommendations.



In addition to promoting physical activity among children, it is equally important to limit sedentary activities beginning in the preschool years (Strong et al., 2005). In this regard, the American Academy of Pediatrics (1999, 2001) recommends that children 2 years or older spend no more than 2 hours with entertainment media daily, and that children under the age of 2 watch no television.

Physical activity patterns of young children

Children appear to engage in very brief bouts of movement of varying intensity, and do not spend much time in vigorous activity (Danner et al., 1991; Pate et al., 2004; Benham-Deal, 2005). Limited data suggest that young children are more commonly involved in light to moderate intensity activities, and place young children in the sedentary to low active category (Butte et al., 2000; Molnar and Livingstone, 2000; Torun et al., 1996; Reilly et al., 2004). There are, however, no nationally representative data describing the physical activity levels of young children (Rennie et al., 2006), and therefore it is not clear whether a reduction in physical activity has contributed to the current epidemic of obesity among young children.

An increase in sedentary behaviours among young children may be contributing to the increase in obesity. Sedentary behaviours such as television viewing can compete with physical activity, thereby lowering energy expenditure (Taras et al., 1989; Buchowski and Sun, 1996; DuRant et al. 1994). A link between time spent watching television and obesity has been documented in preschool-aged children (Dennison et al., 2002); however, this association is not conclusive (DuRant et al., 1994). Daily television viewing increases by approximately 1 hour/year for the first 3 years of life, and then remains relatively constant around a mean of 3–4 hours/day until the age of 7 (Certain and Kahn, 2002). The benefit from reduced television viewing depends upon how children reallocate their time, as they may choose to be more physically active, or to engage in other sedentary behaviours (Epstein et al., 1991, 1995a, 1995b). Furthermore, the relationship between television viewing and obesity may be mediated by factors other than energy expenditure such as concurrent consumption of energy-dense snacks (Fox, 2004a), increased consumption of advertised foods (Borzekowski and Robinson, 2001), or inattention to satiety cues (Epstein et al., 1992, 1997; Temple et al., 2007).

Physical activity patterns are established during the early childhood years (Birch and Fisher, 1998) and may track during early childhood (Pate et al., 1996), from late childhood to adolescence (Janz et al., 2000), and from early childhood to adulthood (Dennison et al., 1988; Powell and Dysinger, 1987; Sallis et al., 1992; NASPE, 2002), declining progressively with age (Janz et al., 2005). Sedentary behaviours may also track to later ages, as children who watched more television in early childhood also watched more television at school age (Certain and Kahn, 2002).



Role of lifestyle factors in obesity prevention in young children

Diet

Despite the increased interest in the role that diet plays in the development of obesity, information in young children is currently limited, perhaps due to the difficulty in obtaining accurate dietary intake data in this age group. Observational studies have linked higher fat diets (Klesges et al., 1995), reduced meal frequency (Toschke et al., 2005), and larger portion sizes of dessert-type foods (Lioret et al., 2007) with greater weight gain among young children. Dietary interventions have helped to elucidate strategies to mitigate these and potentially other obesity-promoting factors. A long-term prospective randomized trial known as the STRIP (Special Turku Coronary Risk Factor Intervention Project) baby study of Finland evaluated the efficacy of counseling parents to provide a low saturated fat, low cholesterol diet to their children aged 7 months to 3 years (Niinikoski et al., 1996). Results from the STRIP baby study suggest that targeted nutrition interventions for preschool-aged children and their parents can improve nutrition knowledge and dietary behaviours of parents, and can improve dietary fat quality, lower lipid levels (mainly boys) and reduce overweight (mainly girls) among young children (Niinikoski et al., 1996; Salo et al., 1999; Rasanen et al., 2003; Hakanen et al., 2006). If sustained, these reductions in lipid levels could have a marked effect on the incidence of coronary heart disease in adulthood. The dietary intervention did not adversely affect infant growth.

Physical activity

Indirect evidence from countries where the use of active modes of transportation is common suggests that children in nations with a culture of physical activity are less likely to be obese (Fox, 2004a). However, there is very little research to support the assumption that greater levels of physical activity among preschool children will prevent overweight or significantly improve health outcomes (Timmons et al., 2007). Of 17 studies reviewed by Hawkins and Law (2006), 7 reported an inverse relationship between physical activity and body fatness, 8 reported that physical activity and body fatness were unrelated, and 1 found evidence of a direct relationship. Although the environment and other factors may limit opportunities for children to be physically active, Wilkin et al. (2006) argue that in young children, activity is biologically regulated and the environment plays only a minor role in between-subject variation.

Although television viewing is associated with obesity in older children (Robinson, 1999; Gortmaker et al., 1999), it is not clear whether the same is true in preschool-aged children, with some studies reporting no association (Burdette and Whitaker, 2005; DuRant et al., 1994) while others report a positive association (Dennison et al., 2002; Lumeng et al., 2006). If an association does exist, it is likely to be multifactorial, operating through a combination of reduced physical activity, increased exposure to advertising for unhealthy foods (Lewis and Hill, 1998), and/or a tendency to snack during viewing times (Lumeng et al., 2006). Mothers' perceptions of neighborhood safety have also been linked to television viewing, with lower perceived safety associated with increased television time (Burdette and Whitaker, 2005). Interventions among preschool-aged children have demonstrated that



reduced television viewing is a feasible behaviour change strategy; however, this does not necessarily translate into increased physical activity or reduced adiposity.

Sleep duration

Early life shortness of sleep increases the risk of childhood obesity (Chen et al., 2008; Kagamimori et al., 1999; Locard et al., 1992; von Kries et al., 2002; Reilly et al., 2005; Agras et al., 2004). The size of the impact of sleep duration on obesity risk in young children is considerable, and similar to other known risk factors for overweight (von Kries et al., 2002). A significant linear dose–response relationship between short sleep duration and obesity in children under 10 years of age is also evident (Chen et al., 2008; Reilly et al., 2005; von Kries et al., 2002; Sekine et al., 2002; Chaput et al., 2006). A combination of earlier bedtime and later wake time may therefore be a low-cost strategy to reduce obesity risk among young children (Chen et al., 2008).

Combined lifestyle approaches

While single strategy interventions have generally not been successful, comprehensive obesity prevention programs that target several behaviours have been shown to promote positive dietary and physical activity behaviours in preschool-aged children over the short and long term, thereby reducing body weight and body fatness (Eliakim et al., 2007; Harvey-Berino and Rourke, 2003; McGarvey et al., 2004; Klohe-Lehman et al., 2007; Livingstone et al., 2006, 2007; Ray et al., 1994). Parents, childcare providers, and preschool teachers are important to the success of interventions instituted among young children. Extensive reviews have been completed regarding the prevention of childhood obesity (see the Appendix).

Critical periods for obesity prevention in young children

Critical periods refer to periods of development when negative factors (or “insults”) may induce permanent changes in the structure and function of organs and tissues (Daniels et al., 2005; Small et al., 2007). Intrauterine life, infancy and the preschool years may all contain critical periods that program the long-term regulation of energy balance (Reilly et al., 2005). Experiences during critical periods that increase the risk for obesity are those that lead to a positive energy balance through excess caloric intake, insufficient physical activity, or metabolic changes that affect energy balance (Agras et al., 2004). Intervention to reduce or eliminate these risk factors may be an important means of reducing the risk for subsequent obesity.

In utero programming

In utero programming refers to the capacity for fetal conditions to impact postnatal health outcomes (Wells et al., 2007). Suboptimal maternal health creates an unfavorable intrauterine environment that can program adipose tissue mass and distribution (Wells et al., 2007), and may increase the risk of metabolic abnormalities such as obesity, hypertension, and type 2 diabetes in the offspring (Power and Parsons, 2000). Children born to mothers who are over- or undernourished prior to, or during, pregnancy are more likely to be obese during early childhood (Whitaker and Dietz, 1998; Johnson et al., 2006; Li et al., 2005 ; Whitaker, 2004; AAP, 2003; Bergmann et al., 2003). Similarly, the intrauterine diabetic environment causes excessive transfer of glucose from mother to fetus



(Wells et al., 2007), and is associated with an elevated risk for high birth weight, obesity, impaired glucose tolerance and type 2 diabetes in the offspring (Pettitt et al., 1983, 1988; Dabelea et al., 1998, 2001; Silverman et al., 1995, 1998; Vohr et al., 1999; Rodrigues et al., 1992; Whitaker et al., 1998a). Maternal smoking is also a known risk factor for childhood obesity at any age (Bergmann et al., 2003; von Kries et al., 2002; Power and Jefferis, 2002; Vik et al., 1996; Montgomery and Ekblom, 2002; Mizutani et al., 2007; Oken et al., 2008).

Extremes of birth weight

The relationship between birth weight and obesity risk has been described as a J- or a U-shaped curve, with a high prevalence of obesity among those born at both extremes (too low or too high) of birth weight (Rogers and EURO-BLCS Study Group, 2003; McMillen and Robinson, 2005; Fall et al., 1995; Curhan et al., 1996a, 1996b). Barker (1995) was the first to put forth the hypothesis that fetal deprivation, as evidenced by low birth weight, may program a propensity for insulin resistance, hypertension and obesity (Hales and Barker, 1992; Prentice, 2005). Barker's hypothesis has become known as developmental programming, and is supported by a considerable body of evidence. Conversely, high birth weights are also known to confer a greater risk for subsequent obesity (Armstrong et al., 2002; von Kries et al., 2002; Oken and Gillman, 2003), with each kilogram increase in birth weight leading to a 0.5–0.7 kg/m² increase in BMI (Parsons et al., 1999).

Whereas early research used BMI as a surrogate for body composition, more recent studies have measured body composition directly. When body composition rather than the BMI is the independent variable, a strong and consistent association between birth weight and lean mass is evident across a range of populations, whereas the association with fat mass is weaker and disparate (Wells et al., 2007). This new evidence, combined with the fact that the population prevalence of extreme birth weights is low (Dietz and Gortmaker, 2001), suggest that birth weight may not be an important target for obesity prevention.

Breastfeeding

Four systematic reviews concluded that breastfeeding is protective against later obesity in childhood and adulthood, although the degree of protection may be small (Owen et al., 2005a, 2005b; Arenz et al., 2004; Harder et al., 2005). Harder et al. (2005) found that the risk of overweight was reduced by 4% for each month of breastfeeding, up to a maximum risk reduction of more than 30% with 9 months of breastfeeding (Harder et al., 2005). Exclusive breastfeeding for 9 months may therefore protect maximally against obesity (Harder et al., 2005); however, concurrent bottle feeding appears to diminish the protective effect of breastfeeding on obesity risk (Bogen et al., 2004).

While breast milk is clearly the best way to nourish newborn infants, some evidence suggests that breastfeeding does not protect against obesity in young children (Burdette et al., 2006; Hediger et al., 2001; Wadsworth, 1999; Agras et al., 1990; Dubois and Girard, 2006; Parsons et al., 2003) or adults (Michels et al., 2007). Given these conflicting data, there is no consensus as to whether breastfeeding is a useful public health strategy for obesity prevention. Even a small protective effect of breastfeeding on obesity risk may be significant on a population level (Arenz and von Kries, 2005), however, and therefore



breastfeeding is still regarded as a low cost, readily available strategy that may help to combat childhood obesity (Dietz, 2001).

Early feeding experiences

Children develop important feeding behaviours during infancy and the toddler years as they learn to feed themselves, try new foods, and experience changes in their level of appetite (Coleman et al., 2005). Indeed, meal and snack patterns are well established by the end of the first year of life (Skinner et al., 2004), and have been shown to impact future obesity risk (Snethen et al., 2007). Infants who are encouraged to empty their bottles, for example, may not learn to control their food intake via internal physiologic cues, and may be at increased risk for overfeeding compared to breastfed infants (Bergmann et al., 2003; Stettler et al., 2005). When feeding is used as a mechanism to soothe frustrated, crying infants, weight gain may result, leading to increased body weight in childhood (Wells et al., 1997). Notably, the timing of the introduction of solid foods may also affect obesity risk. Children fed solid foods before 15 weeks of age had a higher risk of obesity (Wilson et al., 1998); however, the evidence is not consistent (Burdette et al., 2006; Forsyth et al., 1993). Exposure to flavours *in utero* (Mennella et al., 2001, 2004) or during infancy (Mennella and Beauchamp, 2005) can further shape future food preference.

Rapid growth

Singhal and Lucas' (2004) growth acceleration theory suggests that it is not birth weight per se, but accelerated weight change from birth (catch-up growth) that pre-programs a higher risk of metabolic abnormalities later in life. This theory is a potentially unifying hypothesis that might also account for why breastfed infants who typically grow slower than formula-fed infants have long-term cardiovascular advantages, and why an earlier adiposity rebound, indicative of a faster growth trajectory, may be associated with an increased risk for later adiposity (Singhal, 2007).

Rapid weight gain in infancy is most commonly observed among low-birth-weight infants undergoing catch-up growth to compensate for intrauterine growth restriction, and usually occurs during the first year of life (Ekelund et al., 2006). Rapid growth, and especially weight gain, during infancy predicts future obesity in children (Eid, 1970; Ong et al., 2000; Stettler et al., 2002) and adults (Stettler et al., 2003; Monteiro and Victora, 2005; Ekelund et al., 2006; Ong et al., 2006; Baird et al., 2005; Ong and Loos, 2006). In addition to a greater risk for obesity, children who undergo early catch-up growth may also have a heightened long-term risk for metabolic disease (Ong, 2007). Twenty-nine percent of infants aged 0–4 months exhibited rapid growth in one study (Stettler et al., 2003), suggesting that this may be a common phenomenon with important public health implications (Flynn et al., 2006). The relative contribution of the growth rate at different stages of childhood to the risk of later adiposity is not yet clear; however, some evidence indicates that rapid weight gain during infancy may be more significant to future obesity risk than weight gain during the toddler years (Ekelund et al., 2006).

The period of the adiposity rebound may be a time of increased risk for the development of obesity during the toddler years (Dietz, 1994). Most children grow rapidly during the first year of life. Thereafter, BMI declines and reaches a minimum at 3–7 years of age before it



subsequently begins to rise again (Flynn et al., 2006). The age at adiposity rebound is the point of minimal BMI beyond infancy (Cole, 2004). An early adiposity rebound is associated with a higher BMI in adolescence (Rolland-Cachera et al., 1984; Prokopec and Bellisle, 1993; Siervogel et al., 1991) and early adulthood (Rolland-Cachera et al., 1987). The BMI centile is determined by plotting BMI against age and sex, providing a basis for comparing the BMI of children relative to their peers. The BMI centile, and upward BMI centile crossing (the result of weight gain without corresponding growth in height), each predict the age at rebound, with a high centile and centile crossing leading to an earlier rebound (Cole, 2004). An early rebound may therefore simply be a marker for upward centile crossing (Cole, 2004). Because upward centile crossing predicts obesity at whatever age it occurs, Cole (2004) contends that the period of the adiposity rebound does not meet the definition of a critical period for obesity development.

Optimal age of intervention

Success in obesity prevention is most likely to be achieved when preventive measures are initiated early and are sustained throughout childhood and adolescence (Livingstone et al., 2006). Indeed, there may be a very narrow window of opportunity when prevention is possible, given that obesity may be programmed *in utero* and during early infancy. Early intervention is also warranted because excess weight tracks from childhood to adulthood, and becomes more difficult to treat as one becomes older (Dietz, 1999). The available evidence indicates that critical periods for obesity development occur *in utero* (the most significant prenatal insults include smoking, malnutrition and maternal diabetes; Huang et al., 2007) and in the early postnatal years (exclusive breastfeeding for a minimum of 6 months reduces obesity risk; Flynn et al., 2006), and do not justify waiting until the toddler years to initiate preventive measures. Preventive efforts should be directed toward all women of childbearing age and throughout pregnancy, including promotion of a healthy body weight, smoking cessation, and exclusive breastfeeding for the first 6 months of life.

Parental and caregiver roles and responsibilities in obesity prevention in young children

Weight loss

The influence of parental obesity on the weight status of children is substantial among younger children, and is the best predictor of childhood obesity (Parsons et al., 1999; Whitaker et al., 1997). Parental obesity is also influential in the development of adult obesity in their offspring. Indeed, one of the most effective obesity prevention measures may be for parents, guardians, and other caregivers to adopt healthy lifestyles and avoid becoming obese themselves (Summerbell, 2007). Parental involvement is key to the success of early obesity prevention programs (Lindsay et al., 2006). Studies that engage parents as “agents of change” help to reduce childhood adiposity over the short and long term (Golan et al., 1998a, 1998b; Golan and Crow, 2004a, 2004b; NHS Centre for Reviews and Dissemination, 2002).

Dietary intake

The importance of parents in influencing the dietary behaviours of their children may be the most pronounced at younger ages (Oliveria et al., 1992). Young children depend entirely upon their parents for the provision of food (Roblin, 2007); parents determine the



types and amount of food offered, and the emotional context of the eating environment (Davis et al., 2007). Parent–child interactions and encouragement are also closely associated with the eating behaviours and body weights of young children (Klesges et al., 1983, 1986). Authoritative parenting styles characterized by a high degree of parental acceptance and expectation may be superior in encouraging healthy lifestyle behaviours among children (Niklas et al., 2001; Schmitz et al., 2002; Davis et al., 2001).

Four broad aspects of parental feeding style have been examined with respect to their influence on children’s food intake (Wardle and Carnell, 2007). The first two practices relate to the mealtime pressure exerted by parents on their children to eat more healthy foods, more food overall, or to restrict foods that are perceived as unhealthy (Birch et al., 2001). Excessive parental control such as over-restriction of “unhealthy” foods, overly encouraging “healthy” foods, or requiring children to eat when they are not hungry may have the opposite of the desired effect, fostering dislike rather than acceptance of “healthy” foods (Birch and Davison, 2001; Birch et al., 1982, 1984), and interfering with biological regulation of food intake (Birch and Fisher, 1998; Birch, 1998; Fisher and Birch, 2002; Birch et al., 2003).

Young children’s food preferences and intake patterns appear to be largely shaped by the foods parents choose to make available at an early age, and their persistence in offering them (Birch and Davison, 2002). Foods that are initially rejected may be accepted through repeated exposure (Birch and Davison, 2001). Parents should therefore observe a clearly defined role, which is to offer a variety of nutritious food options in a supportive eating context, while allowing their children to decide when and how much to eat (Robinson et al., 2001). This feeding style is believed to promote optimal health by fostering the development of healthy lifestyle habits, self-control, and sensitivity to internal hunger and satiety cues (Robinson et al., 2001).

The last two aspects of parental feeding styles that have received attention in the literature are the use of food as a reward, or to manage children’s negative moods (Wardle et al., 2002). Children learn to prefer foods that are offered as rewards, and to dislike those that must be eaten to obtain a reward (Harbaugh et al., 2007). Parents should therefore avoid using food in these ways.

Because of their considerable influence over children’s intake, it is important that parents and caregivers teach and model healthful eating behaviours during the formative years of childhood. Studies that have sought to change parental, but not children’s, behaviour have shown that changes in parental behaviours produce corresponding changes in children’s behaviours (Kremers et al., 2003; Maccoby, 2000). Family meals provide an important opportunity for parents to role model healthy eating for their children (Roblin, 2007). Families who eat together tend to have healthier diets (Gillman et al. 2000; Taveras et al., 2005), and the children in these families may have a lower risk of being overweight (Veugelers and Fitzgerald, 2005).



Physical activity

Few data exist with respect to the relationship between parental physical activity and that of their offspring (Lindsay et al., 2006). In general, children with overweight parents are less active, and are more likely to prefer sedentary activities (Wardle et al., 2001; Klesges et al., 1990). It is not clear whether parents need to be active for their children to become active; however, children's perceptions of competence, self-efficacy, enjoyment, beliefs, and attitudes strongly influence their activity levels (Brustad, 1993; Welk, 1999). Parental encouragement can therefore significantly impact children's activity levels (Gustafson and Rhodes, 2006). Parents are also responsible for determining the activities that young children engage in during their free time, and for creating an active lifestyle in their household that minimizes sedentary behaviours (Harbaugh et al., 2007).

Childcare environments

Further studies are needed to clarify the relationship between attendance of childcare and obesity risk among young children. It is plausible that adult modeling and encouragement to eat healthier foods may be less effective in childcare settings where children necessarily receive less individual attention (Lumeng et al., 2005). Adults tend to eat more food in group situations (de Castro and Brewer, 1992), and this may also be true in young children (Lumeng et al., 2005). Families who use childcare may also have greater time constraints, relying on pre-prepared or fast food meals, with reduced time for active pursuits (Lumeng et al., 2005). If true, these factors may predispose children in childcare to weight gain; however, there is currently no evidence to support this hypothesis. Childcare providers spend considerable time with many children, and therefore it is reasonable to assume that children's lifestyle patterns may be shaped not only by the food and activity patterns in the childcare environment, but also by the attitudes and behaviours of caregivers.

Roles and responsibilities of health professionals in obesity prevention in young children

Pediatricians and family physicians are ideally placed to identify children at risk for overweight and obesity, as most young children visit their physicians regularly, and weight and height monitoring is routine in pediatric care. Obesity identification is, however, the lowest in children under 5 years (O'Brien et al., 2004), and only 49% of health professionals intervene in cases of preschool obesity (Barlow et al., 2002). Furthermore, despite the fact that they routinely measure height and weight, 6% or less of pediatricians actually plot the BMI for children (Barlow et al., 2007a; Dorsey et al., 2005).

The Canadian clinical practice guidelines (Lau et al., 2007) and the American Academy of Pediatrics (AAP, 2006) recommend that healthcare professionals calculate and plot the BMI annually for all children, and address excess weight gain in children of all ages. However, even for children identified as obese, physician evaluation and treatment are often not consistent with current recommendations (O'Brien et al., 2004; Dorsey et al., 2005). While dietary changes were recommended for many children (71%), increased physical activity (33%) and a reduction in television time (5%) were rarely advised (O'Brien et al., 2004). Although the management of obese children did not meet current guidelines, it was far better than that of children who were not identified as obese, as these



children received little to no advice regarding diet, activity, and other obesity-associated behaviours (O'Brien et al., 2004).

These data demonstrate that physicians are missing opportunities to intervene early in life, and early in the course of overweight/obesity when lifestyle change may be most effective. This failure results in missed opportunities for risk factor assessment, counseling about lifestyle changes, and screening for comorbidities (Dorsey et al., 2005; Miller and Silverstein, 2007). By calculating and plotting BMI for all children, and initiating obesity prevention strategies *in utero*, physicians and other healthcare professionals can play a significant role in helping to curb the rise in overweight and obesity among young children.

The role of population health strategies and public policy in obesity prevention in young children

A population health perspective of obesity prevention

A population health perspective of obesity prevention considers how individual/behavioural and environmental factors interact to affect health outcomes (Raine, 2004). While an excess of energy intake compared to expenditure is the primary individual/behavioural factor responsible for obesity, it is the larger obesity-promoting environment within which behaviours are situated that is the fundamental cause of the epidemic of obesity (Raine, 2004).

An ecological approach to obesity prevention

Diet and physical activity alone are not sufficient to characterize the etiology of energy imbalance in early childhood (Wen et al., 2007); rather, obesity arises from a complex interplay of genetics with environmental factors from multiple interacting contexts. Given this complexity, obesity prevention must be viewed as a community responsibility that is best addressed using multi-level (including multiple interacting individual, environmental, and population-level strategies), multi-sectoral public health strategies, rather than as the sole prerogative of individuals (Dietz et al., 2002; Raine, 2004).

Under the traditional medical model of obesity, the individual is responsible for changing his or her own personal and home environment to assist with weight maintenance and/or loss. Individual-oriented approaches are, however, not likely to be successful without supporting social and environmental changes (Lobstein et al., 2004). Successful population-based approaches focus on changing the environment in which individual behaviours occur, thereby enabling positive change without the involvement or awareness of the individual (Gill, 1997; Wilson et al., 2003; Schwartz and Brownell, 2007). Under this approach, preventive dollars are allocated outside of the traditional healthcare sector, and are redirected toward places where young children spend time, such as kindergarten or preschool programs, daycares, community sports programs, and community children's camps. A comprehensive, ecological approach to obesity prevention combines strategies that support individuals in their efforts to lead healthy lifestyles, with efforts to influence policies that encourage broader social and cultural change (McLeroy et al., 1988).

The increased prevalence of obesity among young children reflects the potency of environmental influences on body weight, and suggests that public health actions are



needed to address these influences (Lobstein et al., 2004). Environmental strategies to prevent childhood obesity include institutional and community-based interventions that focus on promoting healthy living, rather than on obesity per se (Raine, 2004). Environmental policies likely to impact young children include legislation surrounding food intake and time spent in physical activity at childcare facilities. Population-level strategies include a comprehensive range of integrated actions at multiple levels (Stockley, 2001). Population-wide policy interventions likely to impact young children may include regulating portion sizes, subsidies for low-energy nutritious foods, and restrictions on advertising unhealthy foods to children. History provides several examples in which environmental and population-level strategies have been used to successfully alter practices in areas of public health significance, namely in the areas of tobacco use, seatbelts, breastfeeding, and recycling (Raine, 2004). Social change at a similar level will be needed to address the current obesity epidemic (Raine, 2004).

It is not possible to fully characterize the risk factors for obesity, nor to identify all children who may be at risk. In reality, all children may be at risk of developing obesity and could benefit from interventions that promote increased physical activity and a healthy diet (Ells et al., 2005). A comprehensive public health approach circumvents these difficulties by targeting all children (Power et al., 1997b), and may be the most efficacious means of preventing obesity among young children. This should not, however, eliminate the use of targeted interventions in subpopulations that are clearly at increased risk (Ells et al., 2005), nor should broad-based strategies be implemented at the expense of local grassroots movements. Engagement at the community level is key to the success of larger programs, local champions are needed to shepherd initiatives and build enthusiasm, and community sponsorship and partnerships are required to maintain ongoing support for programs (Desjardins and Schwartz, 2007).

In summary, the Public Health Approaches to the Prevention of Obesity Working Group of the IOTF (Kumanyika et al., 2002) recommends that a comprehensive approach to obesity prevention should:

- Address both dietary intake and physical activity patterns;
- Address population- and individual-level factors;
- Address immediate and distant causes;
- Have multiple focal points and levels of intervention;
- Include policies and programs; and
- Build links among sectors.

Government actions to address childhood obesity

The contribution of pediatric obesity to adult morbidity and mortality indicates that childhood obesity prevention should be a high public health priority. Governments have an important role to play in coordinating action among various sectors, and in developing, implementing, and monitoring policies and strategies that support the maintenance of healthy body weights (Raine and Wilson, 2007). Government involvement is most commonly seen in the form of obesity prevention programs, consumer education, obesity surveillance, and investment in research (Ells et al., 2005).



Inadequate surveillance limits our understanding of the context of obesity among young Canadian children and appropriate targeting of prevention efforts. A comprehensive, coordinated and rigorous surveillance program that includes measured BMI, and detailed food intake and physical activity data, is an essential component of an obesity prevention plan (Raine and Wilson, 2007). Canada urgently needs such a formal, large-scale surveillance program with strong links among program developers, advocates, policy makers and other stakeholders (Raine and Wilson, 2007) to inform, monitor and evaluate obesity prevention programs, to determine obesity prevalence and levels of overweight/obesity that signal increased risk for health problems, to assess children's lifestyle habits, and to identify children who are at increased risk of becoming obese.

The Government of Canada is addressing childhood obesity in many areas as outlined in the document entitled, *Childhood Obesity and the Role of the Government of Canada* (Government of Canada, 2007a). In addition, the Standing Committee on Health of the House of Commons recently released a report entitled, *Healthy Weights for Healthy Kids* that includes 13 recommendations to address the problem of obesity among Canadian children (Government of Canada, 2007b). The response document (Government of Canada 2007c) outlines the full range of federal government programs designed to address childhood obesity.

Non-government actions to address childhood obesity

Obesity is not only a problem of public health; there is a need for coordination among many sectors to identify and implement potential solutions (Raine and Wilson, 2007). Public health initiatives can improve the awareness of the contribution that many sectors of society make to obesity-promoting environments, and can focus their attention on minimizing this adverse role (Lobstein et al., 2004). Targets may include changes in the nature of the food supply and in the mechanization of physical activity (Lobstein et al., 2004). Thus, in addition to governments, health-related agencies, educators, healthcare providers, health professional bodies, the research community, families, consumers, and industry must work cooperatively to address the obesity problem (Raine and Wilson, 2007). Natural alliances include partnering obesity prevention with proponents of sustainable transportation, safer neighbourhoods, or those seeking to build parks and recreational facilities (Lobstein et al., 2004). This coordination avoids duplication of efforts, and leverages resources efficaciously toward a common goal (Desjardins and Schwartz, 2007).

Areas for future policy development

According to Raine and Wilson (2007), Canada should consider the following policy options to combat obesity among children:

- Subsidies for the cost of low-energy nutritious foods;
- Taxation policies that promote physical activity;
- Taxation policies that discourage urban sprawl;
- Regulation of food advertising to children; and
- Policies to decrease social vulnerabilities (promote adequate income and higher education).



Additional policy suggestions relevant to obesity prevention among young children include:

- The elimination of barriers to breastfeeding; for example, policies are needed to help mothers continue to breastfeed if they choose to return to work (Dietz, 2001).
- Policies should ensure that families have a range of quality childcare choices available to them, including staying home rather than returning to work (Lumeng et al., 2005).
- Public policy to address risk factors *in utero*: support healthy maternal lifestyles (reduce maternal smoking, healthy diet and physical activity patterns), facilitate breastfeeding, revise current screening practices for gestational diabetes, address food insecurity (Dubois and Girard, 2006; Huang et al., 2007).



Recommendations and Implications

Obesity prevention should target all children beginning *in utero* and continue throughout early childhood.

For consumers (parents, children)...

Parents should be actively involved in obesity prevention strategies for their young children starting *in utero*. Parents and especially pregnant women should maintain a healthy body weight and practice healthy lifestyle behaviours. Exclusive breastfeeding is optimal for the first 6 months of life. Thereafter, positive dietary behaviours can be encouraged through repeatedly offering children a variety of nutritious foods in a positive and supporting atmosphere, while allowing them to decide what and how much to eat of the foods that are offered. Parental encouragement and support for increased physical activity and reduced sedentary behaviours is essential. It is important for parents to ensure that children receive sufficient sleep, and that their BMI is plotted and monitored regularly by a member of the healthcare team.

For Government...

The Canadian Government should formulate a National Obesity Action Plan for the prevention of obesity that targets young children of all ages and women who are pregnant or may become pregnant. The plan must include a formal, comprehensive, coordinated and rigorous surveillance program that includes measured height, weight, BMI (≥ 2 years of age), and detailed food intake and physical activity (≥ 1 year of age) data for young children. Other key elements of such a plan include enacting supportive policies and regulation, coordinated action among all stakeholders, and increased funding for obesity-related research.

For industry...

Industry should consider a range of options such as reformulating food products to be more healthful, offering some food products in smaller portion sizes, limiting or eliminating the



advertising of unhealthy foods to children, offering healthy food options in places where children commonly go, and providing supplementary, credible nutrition information on websites, food packaging, and other resources to educate parents and care providers. Industry can also provide support and funding for community-based obesity prevention programs.

For childcare...

Childcare facilities should participate in obesity prevention initiatives in their community. All children in childcare should be targeted for obesity prevention through the creation of healthy environments that support the consumption of healthy foods and age-appropriate physical activity. Television should be avoided in childcare facilities. Many of the recommendations for parents are also relevant to caregivers.

For health professionals...

Obesity prevention should target all children starting *in utero* and continuing throughout early childhood. Exclusive breastfeeding should be encouraged for the first 6 months of life. All children should receive support in establishing or maintaining healthy lifestyle behaviours, while those at higher risk should receive more active intervention (Barlow et al., 2007b). Physicians should calculate and plot BMI using the CDC growth charts for all children, and assess obesity risk based on BMI and other risk factors such as parental obesity, family medical history, and current lifestyle patterns (Barlow et al., 2007b). Healthcare professionals should not focus solely on diet and physical activity, but must assist parents to manage the environmental context in which individual lifestyle behaviours are situated.

For research...

There is a clear need to augment the body of evidence related to obesity prevention in young children, particularly in the following areas:

The problem of overweight and obesity among young children

- Future studies should attempt to define child BMI cut-offs that relate to health risks in childhood, and should evaluate the utility of waist circumference measurements in assessing health risk among young children.
- Canadian-specific growth curves for BMI and waist circumference should be developed for young children (Lau et al., 2007).
- Canada must continue to collect nationally representative survey data to compare future obesity, dietary, and activity trends to those recently summarized in the 2004 CCHS.

Lifestyle-associated behaviours of young children

- Data collected from national surveys of obesity, dietary, and physical activity trends among children should be used to refine dietary recommendations, and to formulate physical activity recommendations for young children.



Role of lifestyle factors in obesity prevention in young children

- More detailed information regarding the lifestyle determinants of obesity in young children is required. Interventions should be tested longitudinally to assess the sustainability of benefits derived from lifestyle interventions over time.
- Studies are needed to determine the optimal sleep duration for obesity prevention in young children. Randomized controlled trials should be conducted to test the effectiveness of sleep extension for obesity prevention among young children.

Critical periods for obesity prevention in young children

- Studies are needed to ascertain the critical periods that program future obesity risk among young children. Studies are needed to test the efficacy of obesity prevention interventions initiated during critical periods, and to evaluate the optimal timing and type of interventions.

Parental and caregiver roles and responsibilities in obesity prevention in young children

- Future studies should continue to study the efficacy of family-based obesity prevention interventions where parents act as “agents of change”, and should test this model in concert with a variety of lifestyle interventions.
- The impact of a comprehensive range of parenting styles on the dietary and physical activity patterns of young children should be explored.
- Much more work is needed to evaluate the impact of diverse childcare environments on obesity risk in young children.

Roles and responsibilities of health professionals in obesity prevention in young children

- Researchers should evaluate the efficacy of healthcare professional (e.g. physician) screening and interventions for obesity prevention.
- Studies are needed to determine the barriers to healthcare professional screening and intervention for obesity, and how to overcome them.

The role of population health strategies and public policy in obesity prevention in young children

- Studies are needed to evaluate the impact and cost effectiveness of a range of environmental and population-level obesity prevention strategies and policies instituted around the world.

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Additional reviews of lifestyle interventions

Extensive reviews have been completed regarding the prevention of childhood obesity. For additional information on this topic, please refer to the following publications:

- American Dietetic Association, 2006
- Bluford et al., 2007
- Campbell and Hesketh, 2007
- Connelly et al., 2007
- Dietz and Gortmaker, 2001
- Flodmark et al., 2004
- Flynn et al., 2006
- Hills et al., 2007
- Lobstein et al., 2004
- Maffeis and Castellani, 2007
- Sallis and Glanz, 2006
- Summerbell et al., 2005
- Timmons et al., 2007
- Van Sluijs et al., 2007

