A review of current growth monitoring data management systems

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Abstract

Surveillance data have been critical in establishing the importance of obesity as a public health priority. When linked to policy and programme units, surveillance information improves the efficiency and effectiveness of health services by targeting interventions followed by documenting their effect on the population.Assessment of children's height and weight is already well established in Ireland, however currently there is no cohesive data management structure in place relating to anthropometric measurements of children. In Ireland there is a large body of research activity in the collection of anthropometric data in school age children which can feed into an obesity surveillance mechanism and most primary care units gather information on children's height and weight status and if this were to be compiled and fed into a system- would allow for detailed information to be generated or trends in childhood overweight or obese. Therefore there is a need for the development of national data linkage systems across primary care to allow for successful surveillance of childhood obesity.

Introduction

Infancy and early childhood are critical stages in life characterized by rapid physical growth and psychological and cognitive development (Bellisle 2004). The rates of childhood obesity have escalated in the last three decades due to a variety of reasons including increased energy content of the diet, decreased levels of physical activity and increasingly sedentary lifestyles (Han et al 2010, Summerbell et al 2005). Evidence suggests that obesity that develops in infancy may persist throughout childhood and children who become obese before the age of 6 years are likely to be obese later in childhood and adulthood (Quattrin et al 2005, Guo et al 2000). Several studies have indicated that chronic disease may begin in childhood and track into adulthood (Whitaker et al 1997, Godfrey and Barker 2000, Wright et al 2001, Martin et al 2005).

High quality prevalence data are required to guide public health responses. In Ireland there is a large body of research activity in the collection of anthropometric data in school age children which can feed into an obesity surveillance mechanism. However, there is little national data available for children under 5 years of age yet these children are repeatedly measured in the hospital and community setting as part of Statutory Child Health requirements. While there have been great efforts to standardise data collection protocols and services, further work is required in relation to the management of the collected data. The availability of good quality data, collected as part of the existing growth monitoring programme, would allow for systematic surveillance of child growth and weight in this vulnerable age group. This review examines both international and national childhood obesity surveillance mechanisms. We will also examine current exemplars of relevant data management structures and the feasibility of adapting current Irish data management models or International models to growth monitoring data management.

Monitoring overweight and obesity

Development of effective health policies depends on the availability of good data. While obesity data can be extrapolated from research it is routine surveillance that will provide the most robust information (Wilkinson et al 2007). Monitoring and surveillance efforts are intended to discern population subgroup differences and/or trends in diet or nutritional status over time by systematic repeated measurements.

Surveillance is described as the continuous and systematic process of collection, analysis, interpretation and dissemination of descriptive information for monitoring health problems (Buehler 1998). Although the two terms are used interchangeably Byers (1998) has described a distinction between monitoring and surveillance:

"*Monitoring implies the collection and analysis of quantitatively precise measures from representative samples of a population for the purpose of precisely tracking trends.*

Surveillance implies a system of less precise measures intended to trigger timely interventions in response to the detection of meaningful trends". (Byers 1998)

Monitoring systems tend to be part of large population samples with direct measures of diet and nutrition and anthropometry whereas surveillance systems examine smaller samples that are not necessarily representative and use more perfunctory measures. The distinction is therefore defined by the differences in quantitative accuracy of the measures, by differences in the size of the population studied and the timeline of the analysis. The term 'growth monitoring' in children is often used interchangeably with obesity surveillance. Growth monitoring programs are usually conducted at a population level and monitor overweight and underweight children as well as those who are of short or tall stature. The monitoring programmes are generally designed to identify individuals within a population who are at risk of a growth disorder.

A review of growth monitoring in children, was conducted by Fayter et al (2008) to clarify the role of growth monitoring in primary school children, including obesity, and to examine issues that might impact on the effectiveness and cost-effectiveness of such programmes. The studies reviewed were evaluated based on their effectiveness of detecting obesity and other growth disorders according to the UK National Screening Committee criteria. The reviewers concluded that since obesity does not meet the criteria for screening and "identification of effective interventions for the treatment of obesity is likely to be considered a prerequisite to any move from monitoring to a screening programme designed to identify individual overweight and obese children". In addition there are no clear recommendations as to how the target population of any monitoring programme should be defined and there is very little research on the benefits and harms of monitoring.

Obesity screening

In terms of public health, a clear distinction must be made between a surveillance system and a screening programme for obesity. Screening involves an examination to identify people who are at risk of having a disease- the people who are discovered are then treated. Little is known about the outcomes of BMI measurement programs, including effects on weight-related knowledge, attitudes, and behaviours of children and their families. In 1993 a strict monitoring programme was introduced by the Ministry of Education in Singapore which had a legal requirement for all children to be screened annually (Fu et al. 2003). The children identified at the upper end of the BMI spectrum were then engaged in a programme which involved strict interventions such as staying after school and eating lunch separately from other children. Parents were also required to change the diet of their children and schools were penalized if they were found to have children who were obese. The initial outcome of the programme saw notable reduction in the prevalence of obesity but in 2007 the programme was stopped by parents who believed their children were being stigmatized by the intervention efforts.

A recent paper by Wake et al (2009) found that primary care screening followed by an intervention aimed at improving nutrition and physical activity did not demonstrate improvements in the BMI of the children aged 5 to 10 years. As a result, no consensus exists on the utility of BMI screening programs for young people. At present obesity does not meet the usual criteria for the development of a screening programme as described by Wilson and Junger (1968). Screening may only be of value under the following conditions:

- The identified obese individuals are ready for further assessments and are willing to make changes to achieve a healthy weight.
- The capacity for further assessment and treatment is available in the community
- Effective intervention and follow-up programmes are accessible and available for the obese individual (Lobstein et al 2004).

The U.S. Preventive Services Task Force have stated that insufficient evidence exists to recommend for or against BMI screening programs for youth in clinical settings as a means to prevent adverse health outcomes (Whitlock et al 2005) however, the American Academy of Pediatrics (AAP) (2003) recommends that BMI should be calculated and plotted annually on all youth as part of normal health supervision.

Obesity Surveillance

Surveillance systems aim to obtain data to generate population health information on epidemiological trends. The data is collated to observe subgroups rather than individuals and may be used for planning and developing regional or local programmes and therefore there is no requirement for referral for treatment or additional follow-up for individuals. Regional data can then be fed into a national data collation system to provide a national picture of the health problem. The BMI measurements collected at the population can however be used for both surveillance and screening purposes.

German et al (2001) described a number of parameters which indicate the need for surveillance of a health-related event:

- Indices of frequency
- Indices of severity
- Associated inequities
- Costs associated with the health-related event
- Preventability
- Potential clinical course on the absence of intervention
- Public health interest

Obesity meets all of these criteria which urges the need for national surveillance systems to assess the prevalence and incidence of both overweight and obesity and examine their trends over time (Caroli et al 2007).

Surveillance systems in practice

Surveillance is defined as the ongoing, systematic collection of data essential to the evaluation, planning, and implementation of practices, closely integrated with the timely dissemination of data as required by higher authority (WHO, 2006). WHO and the World Bank cite public health surveillance as an essential function of a public health system (World Bank, 2001). When linked to policy and program units, surveillance information improves the efficiency and effectiveness of health services by targeting interventions followed by documenting their effect on the

population. Data collection carried out on a large scale allows for monitoring of obesity at population level and has the potential to provide data for in-depth analysis of various causal and contributory factors. Childhood obesity surveillance provides an important role in the detection of child weight status and essential data which can support the development of appropriate interventions and public health approaches to tackle obesity (National Obesity Observatory, 2009). The main objective for all obesity surveillance programmes include; describing the prevalence of obesity, creating awareness of the problem, identifying demographics or subgroups at the highest risk of obesity, gathering quality data and monitoring progress toward achieving national health objectives and necessary policies.

BMI measuring programmes

The body mass index or BMI is considered to be one of the best available population markers for monitoring obesity trends. A BMI measurement is inexpensive, easy to perform, non invasive and quick (National Obesity Observatory, 2009). BMI measuring has become a popular choice of surveillance means and are used to detect the percentage of the population who are underweight, normal weight, overweight or obese. Although there are 'gold standards' methods for measuring body fat such as magnetic resonance imaging, computed tomography and hydrodensitometry, these methods are unsuitable for population surveillance (Willms, 2004).

Annual school health assessment is obligatory in most western countries with height and weight measurements being integral to most mechanisms and used for monitoring child growth regionally and nationally (Toschke et al 2004; Werner et al 2006). Other countries employ regular national childhood nutrition surveys to estimate trends in overweight and obesity (Wang et al 2000; Matsushita et al 2004; Andersen et al 2005). The various methods of gathering height and weight data in the United States are described below to illustrate the possible methods of obesity surveillance in children. In Europe there are currently only three countries that have purposefully designed routine childhood obesity surveillance systems – Finland, Malta and England. The system in England will be described in more detail here.

USA

In the United States, there are many interconnected efforts to systematically collect information about the health and nutritional status of the population. Many of the surveillance systems and surveys designed to assess child obesity have been in place for 10 to 15 years. A report by the Food and Nutrition Board, Institute of Medicine has described the major surveillance systems

conducted in the US (see Table1) which generally covers the school setting (Institute of Medicine 2006). Most obesity-related activity in childhood is conducted through schools as this is where children spend the greatest portion of their time. Schools in the US, however, are governed by various levels from local school boards to towns or districts. As the prevalence of obesity is rapidly increasing among American children, policy makers and public health professionals are looking at efficient and effective means of slowing and eventually reversing such trends (Dodson et al, 2009). Arkansas stands out at the state with the highest quality surveillance data. Similar to other Southern states, Arkansas is disproportionally burdened by obesity in adults and children. As a result, Arkansas was the first American state to pass comprehensive legislation to combat childhood obesity with the introduction of Arkansas Act 1220 of 2003 (Ryan et al 2006). This act involved the establishment of the country's first annual state-wide BMI screening and surveillance programme for all students in grade K -12, which includes children from 5 years to 18 years. Initially, the act required that the BMI percentile was recorded in each child's report card but this proved contentious for several reasons - namely because it was apportioning blame on the individual student but also because parents found it difficult to interpret. The Act was subsequently changed to disseminate the information in a separate health report. A cardiovascular-risk screening programme in West Virginian schools has measured BMI over the past 10 years in conjunction with an intervention programme which provide comprehensive child health reports to parents (Harris and Neal 2009).

As well as BMI measurements the Arkansas Department of Education, Department of Health and the Centre for Health Improvement use the BMI data obtained to monitor the prevalence of childhood obesity throughout the state. The act also requires schools to restrict vending machines in elementary schools, release information on their food and beverage contracts and created school district Nutrition and Physical Activity Advisory Committees as well as a state Child Health advisory Committee (Raczynski et al, 2009). Results obtained from statewide data completed in the 2003-2004 school year revealed that 38.1% of students were either overweight (20.9%) or obese (17.2%). Following the 2006-2007 assessment year, results showed that 20.6% of students were overweight and 17.2% were obese indicating that there may be a halt to the progression of obesity in these children (Raczynski et al, 2009).

In 2005 the Institute of Medicine provided recommendations for schools to prevent child obesity one of which was to conduct annual assessments of each student's weight, height and gender and age-specific percentile and make this information available to parents. Following this the

IOM called on the federal government to develop guidance for BMI measurement programs in schools. With guidance from an expert panel, the Centers for Disease Control and Prevention (CDC) developed a report to help inform decision-making on school-based BMI measurement programmes (Nihiser et al 2009).

Despite the availability of data there are limitations in the data on different age groups and the size and representativeness of the samples surveyed in the various systems. For instance, since most surveillance systems are school based, pre-school children are not directly engaged with formalized obesity prevention programmes. The Institute of Medicine recommends that self-assessment tools, such as the School Health Index, could be expanded and adapted for preschools, child-care and after-school programs and disseminated through relevant professional associations and organization. The Pediatric Nutrition Surveillance System collects height and weight measures of preschool children but this system is not nationally representative as it samples low-income children.

Opportunities for linking datasets is another area which has not been fully explored in the US and which, using the same methodologies, could allow for tracking of various obesity-related outcomes over time. Researchers in this area have suggested that public health surveillance data collected by states "fostered a heightened awareness and concern that drove policy changes" (Dietz et al 2009).

Table.1 Examples of US Federal Programs for Supporting and Monitoring the prevention of Obesity in Children and Youth

Survey	**Organisation**	**Age group**
Cross-sectional		
National Health and Nutrition Survey (NHANES)*	CDC (2005)	Adults and children
National Health Interview Survey*	CDC	Household level
National Longitudinal Survey of Adolescent Health	Carolina Population Center	Grades 7 to 12
M**o**nitoring the Future	University of Michigan	Grades 8, 10, 12
Paediatric Nutrition Surveillance	CDC	0 to 5 years

System (OedNSS)†		
School Health Policies and programs Study	CDC	All
School Health Profiles	CDC	Secondary Schools
School Nutrition Dietary Assessment Study	USDA	Elementary and Secondary Schools
Youth risk factor behavior surveillance system†	CDC	Grades 9 to 12
School Health Index	CDC	All
Longitudinal Surveys		
National Survey of Children's Health (NSCH)	Maternal & Child Health Bureau, National Center for Health Statistics	0 to 17 years
National Survey of Early childhood health (NSECH)	MCHB, American Academy of Paediatrics	4 to 35 months
National Longitudinal Survey of Youth	US Dept of Labour	12 to 16 years

Evaluation availability: *In progress, † Available

Source: IOM, 2006

Emerging Models of Childhood Obesity Surveillance

As can be seen from the previous section, most childhood obesity surveillance systems that are in place in the USA are connected to schools. Schools are an obvious setting to consider as children are readily accessible and in some countries, height and weight measurements can be integrated with other health screenings. There are disadvantages to school based surveillance systems including absenteeism, parental child consent, training of staff, and provision of mobile equipment such as weighing scales and stadiometers and stigmatization of overweight and obese children.

One of the emerging obesity surveillance models that are being examined in the USA is the registry based model. These use existing immunization or disease registries to aggregate BMI data from clinical sources. Many of these registries are electronic based and are being modified to accept height and weight data, to calculate BMI values and to assign a BMI percentile and weight status to individual children. Data are then aggregated across clinics into a public health

database thus supporting both screening and surveillance. This is a relatively new model and to date only a few states have initiated adding BMI to the immunization database. Indeed in many states electronic immunization databases have yet to be implemented. There are several advantages to the registry based system compared to the school based surveillance system. The measurements are carried out in a clinical setting so staff should be trained and resources are available to evaluate and manage obesity. In addition, as this is done during immunizations data are most likely to be captured on young children, where much data is missing in Ireland. The advantages and disadvantages to these different surveillance systems have been described below (Table 2).

Table 2. Description, advantages and disadvantages of three models of BMI surveillance

	School Based	**Registry Based**	**Hybrid**
Key Features	Teachers or health personnel are trained and equipped to measure children Data aggregated at schools are submitted to health agencies	Height and weight measurements routinely taken by health care providers are entered manually into a database or submitted through automated transfers from electronic health records	Height and weight measurements are taken in health care settings and recorded on required school forms Data are extracted from forms by schools and transmitted to public health authority
Pros	Children are easily reached in schools Height and weight measurements can be integrated with other health screenings School is the primary source of health care for some children	Children are measured by trained personnel in a clinical setting where evaluation and management of obesity can continue Data are most likely to be captured on children under age 6, a strategic population to reach for obesity prevention Funding for health information technology may support automated transfer of height and weight data into registries Data to improve clinical quality are related to obesity prevention and treatment	It takes advantage of school mandates for children to have health exams for school entry and possibly at other ages as well It uses measurements obtained in a clinical setting
Cons	Young and absent children are missed It is not part of the schools' core education mission	The technical capacities of state registries vary Legislative or regulatory changes may be required to permit providers	Educational privacy laws may complicate the transfer of data for use by Health Depts A mechanism to aggregate

	Sepecific training and mobile staff and equipment are required Overweight children would need to be referred to clinical care Overweight children could be stigmatized	to report data or obtain consent A proliferation of EHR may reduce provider motivation to participate in surveillance, if voluntary Only information on children presenting for care is captured. Older children and those lacking access to healthcare may be missed There are privacy concerns about the government having BMI data	the data is needed Errors are common in extracting data from paper forms Information is only available when health exams are required Overweight children could be stigmatized

Adapted from Longjohn et al 2010

Surveillance in the UK

The United Kingdom has developed national guidelines on measuring children's height and weight in the school setting (Ikeda et al 2006). In the UK, information regarding childhood obesity is available from various surveillance systems; Health Survey for England (HSE), National Child Measurement Programme (NCMP), Health Behaviour in School-age Children Study (HBSC) and the Personal Child Health Record (PCHR).

The National Child Measurement Programme

The National Child Measurement Programme (NCMP) (formally known as the National Obesity Database) was established in 2005 and is one of the largest programmes of its kind in the world. A directive from the UK Department of Health issued guidance to Primary Care Trusts on how to measure child-hood obesity, requiring initiation of systems to measure height and weight of primary school children aged 4-5 years and 10-11 years. These two specific indicators of child obesity align with the Vital Signs indicator on child obesity. Every school year, these indicators of obesity inform local planning and delivery services for children, and gather population-level surveillance data to allow analysis of trends in growth patterns. The programme also seeks to raise awareness of the importance of healthy weight in children. The NHS Operating Framework requires all PCTs to develop plans to tackle child obesity, and to agree local plans with strategic health authorities (SHAs). There are also other indicators within the NIS that are relevant to tackling child obesity and that work towards the national ambition.

These include: breastfeeding, take-up of school lunches, the emotional health of children, children and young people's participation in high-quality physical education and sport, and travel to school.

Initial findings from the Child Measurement Programme were published in 2006 (Crowther et al 2006) and a number of practical difficulties were identified. These included technical difficulties such as the transfer of data from the Primary Care Trust to the national database but issues around selection bias where overweight children may have opted out of being measured. These areas were highlighted and addressed with the result that in the following year there was an increase in participation rates from 48% to 80% with improved data quality and greater confidence in the findings.

Prior to the 2008/2009 school year, measurement data were not routinely reported back to the children's parents. However, in 2007, the Department of Health introduced changes to the legislation and parents are now informed of their child's measurements in the hope that this will engage the whole family about health and lifestyle and raise awareness of health issues.

Health Survey for England

The United Kingdom also has other cross-sectional health survey data used to examine trends in obesity. The Health Survey for England (HSE) is an annual survey, monitoring the health of the population which is currently commissioned by the Information Centre (the IC) and children have been included in the survey since 1995. Children from infancy to aged 15 living in households are selected for the survey. Trend tables are published each year updating key trends on a number of health areas. Each survey in the series includes core questions and measurements such as blood pressure, anthropometric measurements and analysis of saliva and urine samples, as well as modules of questions on specific issues that vary from year to year. Height and weight measurements are taken by interviewers for all children, although measurements for those under two years of age are taken by nurses who measure length instead of height. Waist and hip circumference are also measured. Along with the anthropometric measurements, data is collected from a subset of participants on core topics such as general health, fruit and vegetable consumption, alcohol consumption and smoking. Results from the 2009 HSE revealed 16% of boys and 15% of girls aged 2-15 years were classified as obese, and 31% of boys and 28% of girls were classified as either overweight or obese. Results also revealed that there was a strong relationship between obesity and socio-

demographic status with overall girls and boys in lower income families more likely to be obese or overweight compared to girls and boys in higher income families (NHS, 2010).

Health Behaviour in School-aged Children Study

The overall aim of HBSC is to gain new insights into and to increase our understanding of health behaviours, lifestyles and their context in young people. The study also aims at increasing the understanding of how young people perceive health itself (WHO, 1998). The survey is co-ordinated by the World Health Organisation (WHO) and is conducted in 41 countries, including Ireland, enabling cross-national comparisons. It samples around 2000 young people in each of three year groups (year 7 (11 to 12 years), Year 9 (12 to 14 years) and Year 11 (15 to 16 years) in 55 schools every 4 years. The major caveat with this study however, is that all the information is collected through self-completed questionnaires including self-reported height and weight. Research has shown that self-reported height and weight measurement is often unreliable (Nawaz et al 2001).

Personal Child Health Records (PCHR)

The personal child health record (PCHR) is a booklet given to new parents in the UK to be used as the main record of their child's growth, development and uptake of preventive health services. The philosophy behind the record is improved communication, enhanced continuity of care and increased parental understanding of their child's health and development.

Additional data collection in the UK

The Scottish Health Survey and Welsh Health Survey look at adults and children in those regions. The National Diet and Nutrition Survey (NDNS) describe the dietary habits and nutritional status of the population of the Britain. Originally it was comprised of cross-sectional surveys covering the whole population from age 1½ years upwards, split into four different population age groups. : children aged 1½ to 4½ years (fieldwork 1992/93), young people aged 4 to 18 years (1997), adults aged 19 to 64 years (2000/01) and people 65 years and over (1994/95). In 2008 the survey began a rolling programme which will run continuously with field work every year covering a representative sample of adults and children (Food Standards Agency). Several longitudinal studies have also examined obesity including the National Child Development Study, the Millennium Cohort Study, the Avon Longitudinal Study of Parents and Children (ALSPAC).

WHO

The WHO Global Database on Body Mass Index (BMI) was developed as part of WHO's commitment to implementing the recommendations of the WHO Expert Consultation on Obesity: Preventing and Managing the Global Epidemic (Geneva, 3-5 June 1997), which identified the lack of nationally representative cross-sectional data as an obstacle for facilitating international comparisons of adulthood obesity rates, monitoring the magnitude of the current and future obesity problems, and evaluating the effectiveness of intervention strategies.

The Department of Nutrition for Health and Development (NHD) initially developed the WHO Global Database on BMI to provide a systematic collation of available nationally representative and sub-national adult overweight and obesity data. These are reported in a standardized manner using WHO recommended BMI cut-off points to produce internationally comparable results.

During the last four years, the database has evolved in close collaboration with Food and Agricultural Organization (FAO), as a global interactive surveillance tool to monitor nutrition transition covering and reporting on the entire spectrum of adult nutritional status. Currently efforts are being made to undertake a systematic collection of nationally representative studies that also include underweight. The Dietary Energy Supply (DES) data are displayed in conjunction with the BMI data on the maps and in the charts. DES figures are produced by FAO based on Food Balance Sheets (FBS).

WHO Europe

On 30 May 2007, the Commission released a white paper that outlined its commitment to collaborating with WHO in following-up the European Charter on Counteracting Obesity by developing a nutrition and physical activity surveillance system for the 27 countries of the European Union and participating in the development and implementation of the Second WHO European Action Plan for Food and Nutrition Policy.

The WHO European Action Plan for Food and Nutrition Policy (2007-2012) includes, as one of its specific action areas, the establishment of national and international surveillance systems on nutritional status, food availability and consumption, and physical activity patterns in different age and socioeconomic groups, including early childhood. The plan stated that the measurement of nutritional status should include anthropometry and micronutrient status;

dietary intake should consider macronutrients, micronutrients and breastfeeding and complementary feeding should be monitored (section 2.2.4).

Data presented on BMI by European Union (EU) countries, collected by Eurostat uses the Health Interview Surveys (HIS). The HIS data are collected in different years depending on the country, ranging from 1996 to 2003. There is no fixed periodicity in these kinds of health survey and few countries have an annual survey on these topics.

Irish research data on obesity in children

The first Irish survey designed specifically for surveillance of childhood obesity commenced in Ireland in 2008. The survey is part of the WHO European obesity surveillance initiative which is an ongoing, systematic process of collection, analysis, interpretation and dissemination of descriptive information for monitoring obesity. The system aims to measure trends in overweight and obesity in children aged 6.0-7.9 years. The programme uses standardized protocols and sampling framework in order to have a correct understanding of the progress of the epidemic but also allowing inter-country comparisons within the WHO European Region. The results from the first round of the WHO surveillance initiative in Ireland showed that 82% of boys and 73% of girls were normal weight (IOTF cut-offs) and 18% of boys and 27% of girls were either overweight or obese (Heavey et al 2010). The aim is to repeat the survey at 2 year intervals and the second round of data collection took place in 2010. Data is accompanied by supporting information about the schools food and physical activity environment (some elements of this are optional).

Data records on heights and weights of 14,835 Irish children are available from the 1948 National Nutrition Survey (DOH, 1952). No further population data on weight in children was published until the Irish National Nutrition Survey (INNS), in 1990. This was a cross-sectional and nationally representative survey conducted in 14 primary schools (Lee and Cunningham, 1990) providing measured height, weight of 148 8 to 12 year old children. A study of Irish teenagers was conducted by Hurson & Corish (1997) which included lifestyle and dietary information in addition to weight, height and skinfold thicknesses of 390 secondary school pupils aged between 12 and 18.

The Health Behaviour in School Aged Children Surveys has provided childhood obesity prevalence estimates every four years since 1998. The most recent survey collected data from 10,334 pupils aged 10 to 17 years old and 3,404 nine year olds (new in 2006) using European standardised self-completion questionnaires (Nic Gabhainn et al, 2007). The BMI derived from the HBSC studies are based on self-reported heights and weights which, may have has implications for the accuracy of the data but has been used and validated by other countries for determining obesity prevalence. Validation studies have found a high correlation between self-reported and measured weights and heights in school children (Andersen at al., 2005). The distinction of the HBSC study is that it has enabled secular trends in BMI to be observed and also the relationship with sociodemographic status and other health behaviours in children such as alcohol use, self-esteem and bullying.

Griffin et al, (2004) followed up a group of 251 healthy 11-12 year olds over a one year period. Weight, height, waist circumference and triceps skinfold were measured in addition to body image perceptions, satisfaction and slimming patterns of the cohort. As part of a study on dietary supplements in secondary school children Byrne (2003) collected height and weight data on 390 15 to 18 year old adolescents from 9 schools distributed between Dublin and Wexford.

Cross-sectional data on measured childhood BMI is available from the National Children's Food Survey (IUNA, 2005). The survey includes height, weight, waist and hip circumference and leg length measurements from a nationally representative sample of 596 children aged 5–12 years. The measurements were conducted in conjunction with a semi-weighed 7-day food diary which provides the most accurate picture of Irish children's diets to date. Research conducted by O'Neill et al (2007) has described the secular trends of Irish school children using the archived data from the 1948 and 1990 national surveys as the same measurement methodologies were conducted in all studies. IUNA has also recently completed a teen survey which provides similar data on adolescent school-going children.

National epidemiologic surveillance and the proper study of time changes require representative studies with minimal selection bias (Werner et al 2007). Longitudinal studies of nationally representative samples make it possible to conduct analyses both within and between cohorts over considerable periods of time. Longitudinal research of healthy populations is in its infancy in Ireland.

The National Longitudinal Study of Children in Ireland, also known as 'Growing up in Ireland' is a Government-funded initiative. The study will monitor the development of 18,000 children – a birth cohort of 10,000 and a 9-year-old cohort of 8,568 children - yielding important information about each significant transition throughout their young lives. Several measures of health status are included in the study including body mass index. Recent results have shown that 74% of 9 year old children are of normal weight and that 19% are overweight and 7% are obese when the IOTF thresholds are applied ((Layte and McCrory 2011).

A longitudinal study of adolescents was recently completed in three schools in Cork. Close to 200 secondary school students aged between 12 and 17 were studied over 3 years from 2005 to 2007 (O'Connor et al 2008). Study measurements included changes in body mass index, anthropometric measures, dietary intake and physical activity.

The Lifeways Cross Generation Cohort study aims to examine physical and social risk factors of cardiovascular disease through the lifecourse. It was the first Irish study to follow children from the antenatal stage through to early childhood. The study involves 1124 mothers who were recruited during their pregnancy and agreed to participate in the study with their child for an initial 5 year period. It is currently the only Irish study to have data on health, diet and socioeconomic factors during pregnancy with longitudinal information on both the mother and child. One of the unique features of this study is that information is also available from at least a third of grandparents allowing for cross-generational analyses to be performed. Self-reported height and weight measures are available for the mothers, fathers and grandparents at the start of the study. Infant birth weight, length and head circumference is available and measured height, weight and waist circumference was collected at the five year follow-up stage. Data from the five year follow up stage shows that 74% of boys and 70.3% of girls are normal weight (IOTF cut-offs) and 18.6% of boys and 22% of girls are overweight and 7.2 % of boys and 7.7% of girls are obese (Murrin et al 2009).

Measurement of BMI in the Irish healthcare setting

The studies described above were designed to conduct heights and weights measurement of children as part of their overall research objectives. Other research is conducted in the health care setting. In some health settings this is integral to ongoing work whereas in other areas opportunistic measurement of heights and weights was undertaken by interested health professionals.

Appropriate settings for obesity surveillance

The 1970 Health Act established provision of health services for all children up to the age of 6 weeks. Under section 66 of the Act children are entitled to free health examinations and treatment in national school. Current screening and surveillance mechanisms are outlined in Table 3 however there is no standardized approach to the delivery of these services across different health regions.

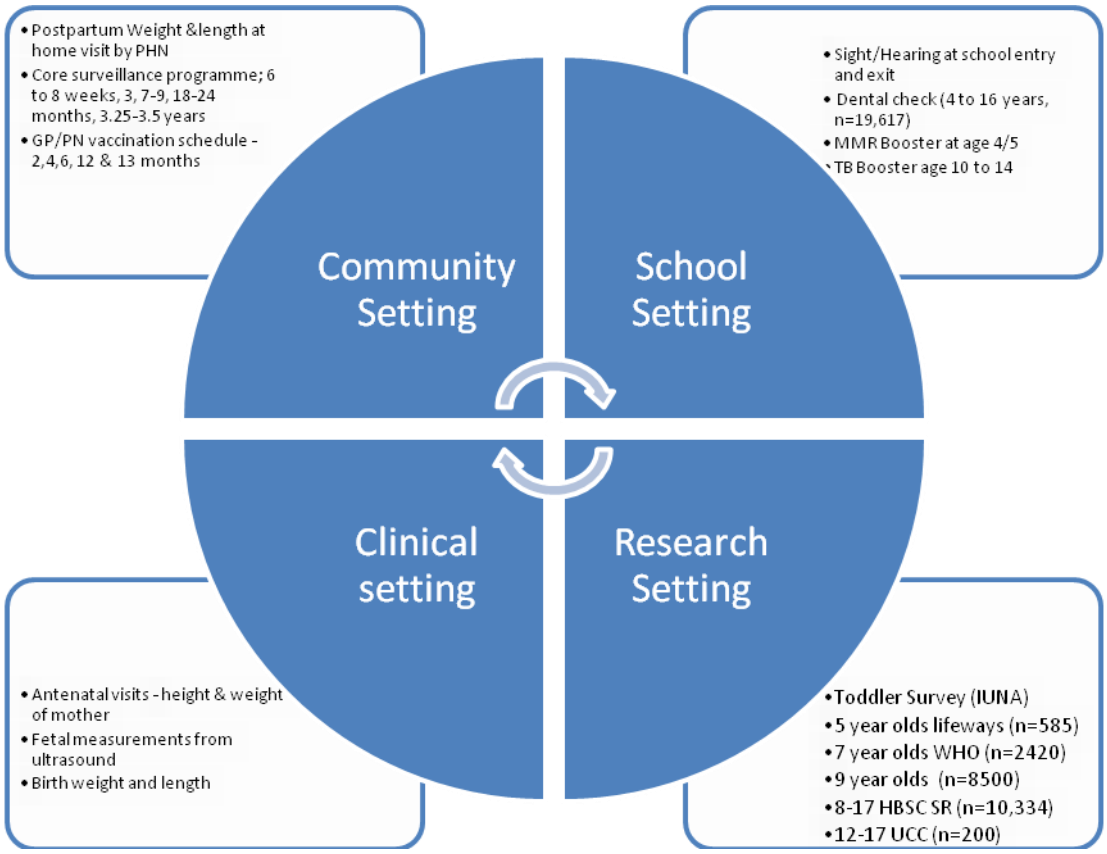
Table 3: Core Child Health Programme

Timing	Developmental	Hearing	Vision	Medical	Growth monitoring
Birth	✓	✓	✓	✓	✓
Postnatal	✓	✓	✓	✓	✓
6 to 8 weeks	✓	✓	✓	✓	✓
3 months	✓	✓	✓	✓	✓
7 to 9 months	✓	✓	✓	✓	✓
18 to 24 months	✓	✓	✓	✓	✓
3.25 to 3.5 months	✓	✓	✓	✓	✓
School entry	✓	✓	✓	✓	✓
School exit	✓	✓	✓	✓	✓

The Statutory national core child health programme includes recommendations for growth monitoring of all children age 0 to 12 years in Ireland. Growth monitoring identifies those children who are not only overweight but underweight and those with growth disorders who are tall or short stature. Appropriately, it does not include a screening process for overweight and obesity. At present children universal monitoring at birth, 6 to 8 weeks, 8 to 12 months and at school entry is part of routine clinical care. In 2001 the national recommendations were piloted in Co. Leitrim and parts of Co. Cavan. School nurses from the original North Western Health Board (now HSE North West) conducted height and weight measurements in addition to testing of visual acuity and hearing. The national recommendations for growth monitoring were revised in recent years by the HSE Programme for Action for Children – Best Health for Children Revisited (2005) and stated that "due to inequities in the resourcing and delivery of this programme, no systematically universally available growth monitoring currently exists for children in Ireland". A working group on growth monitoring developed best practice guidelines for measuring children which included a recommendation to focus on accuracy of measurement and therefore limit the mandatory measures to three stages of development (at birth, 6 to 8 weeks, and school entry).

Other opportunities for measurement, however, should also be utilized. The core child health programme includes assessment for development, hearing, vision, and medical matters at birth, postnatal, 6 to 8 weeks, 3 months, 7 to 9 months, 18 to 24 months, 3.25 to 3.5 years, school entry and exit.

Routine measurement of childhood weight and height can be conducted effectively in a variety of settings. The current opportunities for routine measurement are outlined in Figure 1:



While the opportunities outlined in Figure1 are available the community, clinical and school settings the services may not be consistent in all settings.

Data Systems in Ireland

In clinical settings each maternity hospital conducts and records routine measurements according to varying protocols. Birth weight is one measure which has been collected and recorded systematically in maternity hospitals but the documentation of other anthropometric measures at birth varies between maternity units. One simple example of this is the measurement of weight and length at birth which is recorded in birth charts but in some hospitals only the weight is entered onto the electronic database system. Birth weights and other useful clinical and demographic information are recorded on the Birth Notification registration system which is completed by the hospital and required by the General Register of Births. This form is also used by the Director of Community Care and the Medical Officer of Health in the mother's area of residence to provide community health and social care with the

mother and new born infant. This system is currently used for screening and surveillance services in Ireland. This system is also linked with the National Perinatal Recording System of the Economic and Social research Institute.

Another information system which could provide details on child health is in place in several health authorities is the Child Health Information System (CHIS). There are several different versions of CHIS in practice but the operating principle is the same. Hospitals forward birth details of the infant to the central CHIS office including mother's Personal Public Service number, contact details and some physical information including birth weight. The details are then forwarded to a local CHIS office within the relevant local community care area. There are several different sections to CHIS including the immunizations. Within this system the mothers are contacted to remind them of the vaccination schedule and their GPs are contacted via the community care area who then contact the mothers to remind them of the vaccination schedule. Inclusion of heights and weights measurement during immunization visits is an ideal opportunity to collate BMI data which would automatically be processed centrally.

In 2009, an audit of the Child Health Screening and Surveillance (CHSS) programme as part of the Best Health for Children Revisited (BHFCR) 2005 was carried out. Those LHO areas that use the Personal Health Record (PHR) and its accompanying electronic child health system provided the most complete information for all checks.

As part of this review, it was recommended that a standardized electronic child health information system should be implemented and that the PHR offers a model of best practice as was evident from the number of returns from the areas where this was active and that this system should be standardized and implemented.

The ages which require most attention are the preschool children and post primary adolescents. There are issues surrounding measurements in post-primary children in terms of consent, stigma and also it can be very difficult to compare adolescents due to different growth rates. However there will be some data from the Growing up in Ireland study on 13 year olds. Multiple opportunities exist for the measurement of preschool children, however for surveillance purposes, how this data is captured, processed and managed requires further attention.

The linkage of all child health information would not only provide a better picture of child health in general but would also enable health professionals, educators and parents to establish how the child is developing. Introduction of an infant/child record managed jointly by the community

healthcare team and parents in the first year of life and subsequently by the parents would greatly enhance this surveillance process. Parent-held child records have been strongly recommended for over 10 years as evidenced by the review of child health services in the 'Best Health for Children' report (1999) which recommended an overall model of parent and child centred care. Improvements in data capture technologies may facilitate the collection of this type of information by parents and health professionals. It may also be timely to actively promote the establishment of a patient identification number or personal health record which could greatly improve the administration of health services in the population.

Implications for Policy and Practice

Much can be learned from current and emerging models on the best way to obtain BMI data from children. Factors to consider include the following:

- ***Frequency of Data Collection***: Measurements may be taken at regular intervals or ad hoc. In Ireland there are several opportunities to collect BMI data from children but this should be done in a consistent and timely manner so that growth can be monitored over time. In a clinical setting, children may be weighed and measured at every visit however this frequency of visits will vary depending on the child and may not provide an opportunity to monitor growth. However, for children younger than five years of age, there are several health and immunization checks already in place which would provide an ideal opportunity to monitor weight and height. For older children, the school environment may be a more ideal opportunity to carry out weight and height measurements at critical time periods.

- ***Data entry and recording***: Regardless of where data are collected, a mechanism must be identified to enter data into a database and aggregate them for analysis. Use of or expansion of current systems are likely to be cheaper than the creation of new ones. Within Ireland, LHO areas that use the Personal Health Record (PHR) and its accompanying electronic child health system provided the most complete information for all health checks carried out. This would be an ideal system to implement at a national level. Data from each LHO could then be fed into a central database to provide BMI data for children under the age of five years similar to the systems currently used in the USA as part of the immunization programmes. For older children, there are several surveillance mechanisms in place, most notably the WHO COSI and Growing Up in Ireland. Co-ordination and follow up of these systems may provide high quality prevalence data which are required to guide public health responses.

- ***Limitations of various settings***: Measuring and reporting children's health data requires attention to accuracy and privacy. In clinics and schools, equipment should be calibrated, staff should be trained, and information should be shared with families in a sensitive manner.

- ***Representative data***: Many children do not receive routine medical visits and so data collected in the clinical setting might not be representative of the entire population for surveillance. Therefore measurements carried out at the health checks and childhood immunizations may be more representative particularly for the under 5's. School based data may also be more representative but issues such as consent at the child and parent level may influence this.

- ***Sharing Data with Families***: Although the surveillance systems currently used in Ireland do not routinely provide parents with results, within the UK and USA this has become standard. Similarly, focus groups investigating parents' attitudes to child measurements showed that most parents would prefer feedback as they could not see the purpose in the exercise otherwise. For this reason, if results are to be provided, guidelines for communicating results to parents should be followed.

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