Health and Nutrition in Adolescents and Young Women: Preparing for the Next Generation

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Foreword

The focus of the 80th Nestlé Nutrition Institute Workshop (Bali, November 2013) was to get more insight into the influence of maternal health and nutrition on fetal and postnatal growth and health of the offspring. Two previous NNI workshops with the topics ‘Importance of the First 1,000 Days’ [1] and ‘International Nutrition: Achieving Millennium Goals and Beyond’ [2] already had nutrition topics related to pregnancy and lactation as part of the program. The topic of the 80th Nestlé Nutrition Institute Workshop ‘Health and Nutrition in Adolescents and Young Women: Preparing for the Next Generation’ went beyond ‘the first 1,000 days concept’ and discussed the importance of health and nutrition of future mothers from their adolescence to pregnancy.

During the workshop, it became clear that nutrition of young women and how it can affect the offspring is an almost neglected topic in both developed and developing countries. Only recently have international NGOs and research groups [3, 4] begun addressing this topic. Both under- and overnutrition of the mother can negatively program the child’s health. The recent Lancet series [3, 4] provides insights into how maternal undernutrition and micronutrient deficiencies are related to low birthweight (LBW) and intrauterine growth retardation. LBW babies have a higher risk of morbidity, stunting and mortality between birth and 5 years of age. Recently, it has been shown that maternal undernutrition results in epigenetic programming during conception and in the newborn which is associated with negative health outcome [5]. There is also evidence that LBW babies have a higher risk of developing noncommunicable diseases such as obesity and related complications – diabetes, cardiovascular disease, and stroke later in life [6]. Long-term studies in offspring from obese mothers indicate a lower lifespan, which could be related to the higher risk of having metabolic syndrome in their adult life [7]. In their final comments, the chairpersons pointed out that targeting nutrition of female adolescents and young women during their reproductive age is crucial for both mothers’ health and long-term health outcome of their children.

We would like to thank the three Chairpersons for putting the program together: Maria Makrides – Director of the Women’s and Children's Health Research Institute, University of Adelaide; Zulfiqar Bhutta – Director of Global Child Health, Hospital for Sick Children in Toronto, Founding Director of the Center of Excellence in Women and Child Health, Aga
Khan University, Pakistan, and Andrew Prentice, Director of the MRC International Nutrition Group, London School of Hygiene and Tropical Medicine. We would also like to thank the renowned speakers, moderators and scientific experts in the audience, who have significantly contributed to the workshop. Finally, we very much appreciated the excellent logistic support provided by the teams from Nestlé Nutrition in Southeast Asia and Indonesia.

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Adolescent Health Globally: Issues and Challenges

George C. Patton and Susan M. Sawyer

Rapid declines in fertility, increasing survival through infancy and childhood and greater longevity mean that this generation of adolescents will be the largest in human history. In low-income countries, the ‘youth bulge’ has the potential to bring great economic prosperity. In contrast, many high-income countries face a ‘demographic cliff’, where a smaller pool of young people poses major economic and social challenges. In both contexts, the health and well-being of this generation of adolescents will determine future national development.

Shifts in adolescent development have major implications for health. Falls in the age of puberty together with a rising age of marriage have, for example, given rise to more sexually active unmarried adolescents. In settings where healthcare needs are well met, the benefits are clear in terms of lower pregnancy rates, lower maternal mortality and lower rates of HIV and other sexually transmitted infections. Conversely, where this shift occurs in settings with poor adolescent health care, where sexual activity in young unmarried women is stigmatized and where poverty forces young women into early marriage or selling sex, both health and life outcomes can be catastrophic. In this context, poor and socially marginalized adolescents, particularly those out of school, without stable accommodation or family, or in juvenile detention, have the worst health profiles.

The opportunities for gain or loss are great across all aspects of health in adolescence. It is during these years that the risks for injury and mental disorders are highest, and when risks for later-life noncommunicable diseases (cancer, cardiovascular and respiratory disease) such as tobacco use, obesity and inactivity are established. The great majority of adult mental disorders begin in adolescents. So too injuries rise sharply with high rates of suicide, motor vehicle injury and violence, including sexual violence in these years. All will affect the future health, social adjustment and economic prospects of today’s adolescents. It will in turn affect their capacities as parents and a healthy start to life for their children.
There is great variation between countries, even within the same region, in patterns of adolescent health. For low-income countries, key indicators at national and district levels should include rates of maternal mortality, HIV and sexually transmitted infections, age of onset of sexual activity, early childbirth, availability of contraception and age of marriage. Countries should also have data on adolescent nutrition including anemia, patterns of injury including sexual violence and coercion, mental health and disorder, and substance abuse. At a local level, data on family functioning (e.g. violence, conflict), educational engagement, peer behavior and community attitudes (e.g. to providing contraception to sexually active unmarried adolescents) are also needed to effectively guide programming and health service delivery.

The evidence base for prevention in adolescence is stronger than ever before. Public health approaches that use multiple coordinated actions at national and local levels show great promise. These typically involve steps of using best available data to evaluate local needs, identifying priority targets for intervention, implementing evidence-based programs and policies followed by monitoring, commonly using the same indicators that framed need.
Preconception Care and Nutrition Interventions in Low- and Middle-Income Countries

Zulfiqar A. Bhutta and Zohra S. Lassi

Preconception care is no longer a new concept. Health research since the 1960s has made it clear that since prenatal care improves maternal, newborn and child outcomes, preconception care is simply a logical extension. Maternal nutrition plays an important role in pregnancy outcomes and in the health of the newborn, and providing simple nutritional interventions before pregnancy can prevent a significant proportion of maternal and neonatal mortality and morbidity. Preconception care allows the time needed for behavioral changes to occur and for interventions to have the maximum impact on optimizing the health of the mother-to-be. In developing countries, particularly, where there is the highest burden of maternal and newborn deaths, preconception care provides opportunities both in the community and healthcare settings to deliver basic interventions such as nutrition to improve the health of women and their babies.

A systematic review was undertaken to assess the impact of preconception nutrition interventions that can improve maternal, newborn and child health outcomes. In total, 131 randomized, quasi-randomized and observational studies were used in the meta-analyses.

Optimizing Maternal Weight

Both prepregnancy overweight and underweight are risk factors for poor maternal and child health outcomes. While maternal prepregnancy overweight and obesity increase the propensity for gestational hypertension and diabetes, and the risk of stillbirths and congenital heart defects, underweight women have a higher incidence of stillbirths and preterm birth, low birthweight and small-for-gestational-age babies. Although restricting weight gain might seem an easy solution, there is little evidence for the effect of this as the primary intervention in overweight women. Balanced protein energy supplementation and appropriate micronutrient
supplementation could reduce the risk of prepregnancy underweight and adverse perinatal outcomes. In the recent past, the urbanization and increasingly sedentary lifestyles in low- and middle-income countries have resulted in a nutrition transition, where the population is suffering from a double burden. It is therefore important for women to understand the risks associated with being overweight or underweight during pregnancy, and they should be encouraged to normalize their BMI before pregnancy since weight loss during pregnancy is not recommended, and weight gain during pregnancy does not sufficiently reduce the risk for pregravid underweight women.

**Micronutrient Supplementation**

The preconception micronutrient status of women is crucial. Substantial evidence exists for the potential of preconception folic acid supplementation to more than halve the risk of neural tube defects. Multivitamin supplementation lowers the rates of preeclampsia, and multiple congenital anomalies. The main reasons for a low prevalence of use in low- and middle-income countries include low maternal education and socioeconomic status, young maternal age and unplanned pregnancy. It is therefore necessary to improve awareness and use of folic acid supplements among all women of reproductive age, so that even women with unplanned pregnancies are protected. Public health policy in some countries now mandates that staple foods, such as flour, be fortified with folic acid.

Supplementation of other micronutrients (for example iron and iodine) may correct biochemical deficiencies, but is usually begun during pregnancy, and trials do not link this with an improvement in maternal, newborn and child health outcomes. Future trials, therefore, need to focus on how pregravid provision of iron, vitamin A and iodine supplements could possibly lower adverse pregnancy-related outcomes and the best way of implementing supplementation programs for the general population, especially targeting women of reproductive age.

Provision of healthy nutrition and supplementation during the preconception period ensures that risk is minimized and that women are in the best health possible at the start of pregnancy before the crucial time of fetal development and before health problems can lead to adverse maternal outcomes. Food fortification with micronutrients along with intensive promotional campaigns and counseling by healthcare providers could increase the coverage of daily multivitamin supplementation.
Adolescent Health and Nutrition in the US and Canada: An Overview of Issues and Determinants

Miriam Kaufman

Adolescence is a developmentally dense time of life, with solidification of personal identity, ethical beliefs, approach to the world, patterns of friendships, cognitive sophistication and sexual and gender identity. The tools used to reach adulthood in a number of domains include taking risks, developing opinions contrary to parents’, practicing negotiating for themselves. Some of these tools can also be health risks if they involve substance use, unprotected sex or illegal activities. Rapid brain development that continues into the third decade of life accounts for many of the changes of adolescence, but this can be affected by environmental and social factors. Healthy adolescent outcomes include achievement of developmental tasks.

Adolescents tend to be generally healthy on a physical level. Death rates go up with age and are significantly higher in males. In the US, ‘accidents’ (in particular, unintentional injuries involving motor vehicles) lead the list, with homicide and suicide following [1]. In Canada, adolescent deaths are also mainly caused by unintentional injuries (more than a third of deaths in 15- to 19-year-olds) followed by suicide (about a fifth of deaths) with neoplasia as the third highest cause [2]. However, ‘fatal’ childhood conditions such as congenital heart disease and cystic fibrosis continue to see an increase in survival into adulthood.

Adolescents in these two countries are facing numerous challenges, although the challenges are often different or may be responded to in different ways. Issues for aboriginal youth include those of education, nutrition, housing and racism. Racism is not limited to this group either and is also intertwined with the issues faced by immigrant youth. Lesbian, gay, bisexual and transgendered youth have high rates of suicide attempts and completed suicides, with the root cause usually being homophobia and transphobia. Gender inequality, although less pronounced than in many areas of the world, is still an important determinant of poor health in both
countries. Access to high-quality education is particularly problematic in the United States. Alcohol and other substance use lead to health issues and also educational problems. Adolescent pregnancy, access to abortion and adolescent parenting are issues in both countries, although the issues are more extreme in the US. Finally, the care of children by the state within the foster care system leads to significant issues in adolescence and adulthood. Mental health issues are not specifically addressed.

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Nutrition Challenges and Issues of Relevance to Adolescents in Low- and Middle-Income Countries

Andrew M. Prentice

‘Every day, 20,000 girls below age 18 give birth in developing countries’ [1]. The proportion of pregnancies taking place during adolescence is about 2% in China, 18% in Latin America and the Caribbean, and more than 50% in sub-Saharan Africa. Half of all adolescent births occur in just seven countries: Bangladesh, Brazil, Democratic Republic of the Congo, Ethiopia, India, Nigeria and the United States.

Such births are associated with numerous hazards to both the mother and baby. Although adolescents aged 10–19 years account for 11% of all births worldwide, they account for 23% of the overall burden of disease (disability-adjusted life years) due to pregnancy and childbirth.

The nutrition-related hazards associated with adolescent pregnancies can be divided and summarized as shown below.

**Stunting (Current and Future)**

Young mothers who have not yet fully grown have smaller pelvises and a consequent increase in the likelihood of an obstructed labor due to cephalopelvic disproportion (in spite of having an increased likelihood of having a low-birthweight baby with a lower head circumference; see below). Moreover, a prolonged adolescence in poor societies offers an important chance for catch-up growth that is largely terminated if the girl becomes pregnant due to closure of the epiphyses. Figure 1 shows that stunted African girls can catch up by almost a whole z score by virtue of an extended pubertal growth spurt that frequently is incomplete until some years into their third decade. If not impeded by an early pregnancy, this catch-up would offer significant obstetric benefit throughout the mother’s reproductive span.
Maternal/Fetal Competition for Nutrients

Compared to most other mammals, the nutrient stress of pregnancy in humans is rather low as a result of the very slow fetal and postnatal growth rates that are an evolutionary consequence of adopting a large brain that needs time to construct and train. Nonetheless, many mothers lack the resources to meet even these small additional needs and are forced to adopt energy- and nutrient-sparing adaptations during the reproductive cycle. Clearly, the need for such adaptations is increased when a mother is attempting to share her nutritional resources between growth and reproduction. Studies have revealed complex biological decision-making in relation to the division of resources between growth and reproduction. A pregnancy that competes with the adolescent growth spurt clearly puts the mother at an elevated risk of deficiency.

Low Birthweight, Low Head Circumference

Adolescent pregnancies result in a higher likelihood of low birthweight and of babies with hypocephaly, both of which are associated with long-term detriments to the offspring.
Anemia

Anemia is a key risk in pregnancy both in relation to the future development of the offspring and to the risk of maternal mortality due to hemorrhage. Adolescents are not necessarily at a greater risk of anemia than older mothers, but the risks of fatal outcomes seem to be higher.

Poor Breastfeeding Skills

For cultural and family reasons, many young mothers are trying to cope without the maturity and knowledge of older mothers and are struggling without the benefit of family support and advice. This can result in very low rates of adequate breastfeeding; though it should be stressed that this is not the norm where early marriage and motherhood are part of the culture of society.

Obesity

The nutritional transition in many emerging nations is affecting younger women as they embrace unhealthy diets and sedentary behaviors. Thus, although obesity is generally a disease of the middle-aged, it is becoming a very significant risk in middle-income countries and carries with it a host of additional pregnancy-related risks.

Epigenetic Programming

The evidence associating a low methyl donor metabolome with intra- and intergenerational sequelae linked to epigenetic gene modifications is rapidly strengthening, and though we do not yet know what is the ideal pattern of nutrient balance for the periconceptional period in mothers, there is no doubt that variations can potentially cause permanent programmed changes in the offspring. For instance, we have shown in The Gambia that seasonal changes in dietary patterns have significant effects on the methylation patterns of alleles that are methylated at the very start of pregnancy. It is possible that maternal-fetal competition for nutrients could result in unfavorable methyl donor patterns in young mothers.

These nutritional concerns reinforce the host of other reasons as to why interventions to avoid adolescent pregnancies should be a high priority.
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Social Determinants of Health in Adolescents and Young Women’s Health and Nutrition: Current Evidence

Adesegun O. Fatusi and Bamidele Bello

Introduction

Adolescence is a nutritionally vulnerable stage of life as a result of physical, physiological, lifestyle and social factors. Nutrition is a leading adolescent health challenge globally. The leading problems are undernutrition, obesity and iron deficiency anemia. Obesity is a greater challenge in high-income countries, while undernutrition presents higher challenge in low- and middle-income countries (LMICs), although the level of obesity is also rapidly increasing in many LMICs. Early pregnancy exerts additional nutritional burden on adolescent girls. The prevalence of underweight among adolescent females (15–19 years) is as high as 34% in Niger and Senegal, 35% in Bangladesh, and 47% in India.

We review the current evidence about the social determinants of health (SDH) in adolescents and young women’s health and nutrition. SDH is defined as ‘the conditions in which people are born, grow, live, work and age’ [1]. SDH, as a public health approach, tends to shift the focus away from individual behavioral causes of disease toward factors that are beyond the control of the individual – social, economic, political, cultural, and environmental determinants of health, which constitute the ‘causes of the causes’. Adolescence presents a second chance in human life cycle to address inequities; thus, SDH is important to adolescent health and nutritional outcomes.

Social Determinants of Health

Based on the WHO’s Commission on Social Determinants of Health framework (fig. 1), two broad groups of factors were examined from the literature: structural and intermediary determinants. The structural determinants of health, which include macroeconomic and policy
context, determine, to a large extent, the health opportunities of social groups based on placement within hierarchies of social and economic power and relative social capital available in communities.

**Social Determinants of Health and Adolescent Nutrition**

*Structural Determinants*

A review of experiences in Eastern European countries that changed from communism to market-based economy showed that the macroeconomic and policy frameworks influence food availability and consumption pattern [2]. Greater national wealth and lower level of inequity are significantly associated with better health outcomes for adolescents across several domains, while youth unemployment is associated with poor health outcomes among adolescents [3].

*Intermediary Determinants*

Intermediary determinants include material conditions, behavior and biological system, psychosocial factors, and the health system. Rural areas, which are generally worse off than urban areas, particularly in resource-challenged low-income countries, are associated with higher level of adolescent and maternal undernutrition [4]. Behavioral factors...
such as nutritional habits, physical activity and other lifestyle practices impact on dietary intakes and utilization of foods. Biological factors include genetic issues, rate of maturation and physiological processes such as pregnancy. Male and female adolescents generally manifest different nutritional behaviors; females are more selective about food and more preoccupied with body image than males. Family and peers exert influence on nutritional behavior of adolescents, and the same is true of health systems’ actions.

**Conclusion**

SDH are critical to reducing inequalities and improving health and well-being, particularly in adolescence. Adolescent health policy and programmatic interventions need to take SDH into account in the design and implementation, so as to reduce inequities and improve health and well-being. More studies on SDH in adolescent health and nutrition are needed.

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Platforms for Delivery of Adolescent-Friendly Health Care

Susan M. Sawyer and George C. Patton

The type of health issues that affect adolescents has changed, with significant implications for how health services are oriented to address these needs. Sexual and reproductive health is still a major problem in many low- and middle-income countries (LMIC), but HIV/AIDS, sexually transmitted infections and unsafe abortion are increasingly affecting unmarried as well as married girls. While undernutrition remains a key problem, the epidemic of overweight and obesity is increasingly affecting adolescents in LMIC as in the high-income world. Mental disorder and risk for later noncommunicable diseases (e.g. tobacco use) typically have their onset during adolescence, and accidents and injuries disproportionately affect the young. Yet, historically, health services in LMIC settings have assumed that adolescence is a healthy period of life, and that adolescents have little need to engage in health services. Adolescent-friendly health care refers to the provision of quality healthcare for adolescents. The goal is that health services are available and able to respond to the changing needs of young people. In particular, the challenge is for health services to actively engage young people in their own healthcare, rather than operating through their parents. Yet there are many barriers. The most important relate to access, acceptability and appropriateness of healthcare. A particular challenge is to provide healthcare to young people that is private and confidential, and that ‘goes beyond the presenting complaint’ as there is often a gap between the illnesses that young people present with to health services and the presenting complaint. Psychosocial history taking is the most common tool for engaging young people in their health care and identifying the range of health issues they experience. Active engagement helps set expectations around self-management practices, is a prerequisite to behavior change, and a strategy to support future engagement with adult health services. A challenge for health educators and health services is to ensure that the contemporary health workforce is appropriately skilled to provide adolescent-friendly healthcare to all young people and that health services have an appropriate policy.
framework in place to deliver the health services that young people need. In addition to primary care services (whether in community health centers or schools), new platforms for health care delivery are increasingly accessible to young people across the world. There is much interest in the role of immunization as a point of contact with health services that provide a wider range of interventions. Media-based interventions provide great promise as a platform for health education and behavior change, although trials of media-based interventions are still very limited with modest effect sizes.

The health of adolescents and young adults is gaining new attention globally with growing appreciation of the importance of adolescence within the life course. Sexual and reproductive health remains a major problem in many LMIC. However, growing numbers of unmarried sexually active girls have resulted in increasing rates of sexually transmitted infections including HIV/AIDS and unsafe abortion in unmarried as well as married girls. While undernutrition remains an issue in adolescents in many parts of the world, the epidemic of overweight and obesity is increasingly affecting adolescents in LMIC. Once considered insignificant beyond adolescence, health-related behaviors and states that are adopted during adolescence (e.g. substance use) or that commonly have their onset during adolescence (e.g. overweight and obesity, mental disorders) are now appreciated to have profound significance during adolescence itself, in later adult life and for the health of the next generation [1].

There is growing evidence for preventive interventions targeting community level, education and welfare settings to improve adolescent health and well-being [2]. There is also growing evidence that various platforms for health care delivery provide important opportunities for adolescents and their health, including preventive interventions [3]. In most parts of the world, primary care remains the most important platform for health care delivery to adolescents, although a range of other platforms are also available.

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Polycystic Ovary Syndrome in Young Women: Issues and Consequences

R.J. Norman and L. Moran

Polycystic ovary syndrome (PCOS) is the commonest endocrine condition encountered in young women and has many reproductive, metabolic and psychological features that lead to patients consulting medical practitioners and the health service.

The etiology of the condition is undetermined but has familial and lifestyle features reflected for instance in the various ways PCOS presents, although it was originally described as a reproductive condition with infertility, lack of ovulation, menstrual disturbances, a higher prevalence of endometrial cancer and obesity. However, research over the past few decades has emphasized the importance of metabolic parameters in the pathophysiology of the condition. The prevalence of diabetes is greatly increased, regardless of the body mass index, and an abnormal lipid profile together with enhanced insulin resistance increases the cardiovascular risk factors for the patient. Many studies have shown hyperinsulinemia and associated insulin resistance: this varies considerably between ethnic groups (South Asians appear to have a very high prevalence) and body shape (those with central obesity have much higher insulin resistance than those with peripheral obesity). There is some doubt as to whether obesity is more common in PCOS or not. We have published an extensive systematic review that shows that data from the literature indicate patients with PCOS have a much higher prevalence of obesity, although large community-based studies appear to support the fact that obesity is no more common among patients with PCOS than the general community. This would suggest there is a strong publication bias in favor of the most affected patients and that those with overweight or obesity present to hospitals more commonly than those with a normal weight. Various data from the Australian longitudinal women’s study suggest the prevalence of PCOS increases with rising obesity rates, and therefore control of weight gain would appear to be an important treatment parameter. Substantial data on the prevalence of metabolic conditions and of overweight and obesity are based on published literature rather than community studies.
Overweight and obesity are common among many groups of young women with PCOS and may precipitate subsequent reproductive and metabolic disorders that require expensive and invasive care. Attention to nutrition and diet is important in management of these young women. Occasionally, bariatric surgery may be necessary for severe overweight conditions.

While there is little evidence from a metabolic cause for changes in appetite and fat deposition, there is a need for intervention to prevent weight gain and promote weight loss. It appears as if caloric restriction is the most important feature of treatment ahead of changes to the macro-nutrient component of the diet. Introduction of an active lifestyle is also encouraged. As obesity rates increase and infertility is more common, nutritional interventions have a role to play in fertility. Given the rising increase in risk in diabetes mellitus and the potential effects on cardiovascular events that will arise, health services need to approach PCOS with adequate nutritional resources for dietary intervention and advice.

Psychological assistance is also important, and a model for clinical care should include specialists, primary health care physicians, allied health including dieticians, and the patient should hold the health care plan. These clinical models should be based on the latest evidence-based guidelines such as that recently published by the PCOS Alliance in Australia.
The world now sees an alarming situation of increased and perpetually rising incidence of obesity as well as diabetes. The statistics point to a grave scenario as the occurrence of obesity in adolescents has tripled and in general population has doubled in the past 30 years. These figures translate into a huge number as in 2010 more than one third of children and adolescents were overweight or obese. This signals a global crisis as obesity and diabetes surface as a widely rampant form of health concern of individuals worldwide that needs to be immediately addressed.

A systematic review was undertaken to assess the impact of interventions that can prevent and manage obesity, prediabetes and diabetes in women and adolescents. In total, 100 randomized, quasi-randomized and observational studies were used in the meta-analyses.

Studies on lifestyle interventions to prevent and manage obesity found that dietary and physical interventions and counselling can significantly reduce adiposity. Similarly, lifestyle modification that includes dietary advice, physical activity and/or behavioral therapy for obese adolescents can also improve BMI. It is therefore important to implement such strategies at school and community level programs and to encourage teachers and parents to encourage their children to be more active, eat healthy and spend less time in activities which do not involve physical movements.

While obesity is a fast growing epidemic, evidence shows a BMI-dependent relationship between prepregnancy obesity and adverse pregnancy outcomes. There is evidence to support exercise as an intervention to decrease the risk of gestational diabetes mellitus (GDM), preeclampsia, maternal weight gain, and increase the chance of a normal delivery. Physical activity is not only effective in reducing weight in women, but the evidence was more convincing as it reduces the risk of GDM by 53%.
The counselling and care for overweight/obesity and diabetes as a consequence is crucial for young women before they become pregnant to avoid the occurrence of the adverse maternal, newborn and child health outcomes. It is important to educate young women about the interplay of weight and diabetes, self-management skills such as diet, exercise and other reproductive advice. Meta-analysis of studies using counselling and dietary advice as interventions in young women showed reduce occurrence of congenital malformations and perinatal mortality.

Proven evidence exists on the management for women with GDM; however, little is known about the effects of treating women with hyperglycemia who do not meet diagnostic criteria for GDM and type 2 diabetes. A review on dietary counselling and glycemic monitoring in women with borderline diabetes found promising results on pregnancy outcomes.

Management of GDM includes many interventions that are based on dietary advice, exercise, and pharmacological approach. While dietary interventions showed that women on low glycemic index diet had fewer large-for-gestational-age infants and lower maternal fasting glucose values, there was inconclusive evidence regarding the usefulness of exercise. There is also a need for further research to determine the best pharmacological regime to be employed in the management of GDM.

Given that weight is a modifiable risk factor, it is important to recognize that supportive environments and communities are fundamental in shaping people's choices and preventing obesity and diabetes. Research must now focus on how healthcare providers and public health campaigns can reduce these risks at the school and community level. Public health campaigns should also direct their focus to young and adolescent girls to make them aware of the importance of healthy eating, physical activity and maintaining normal weight for their own well-being as well as for the problems they could face during pregnancy. Therefore, it is important to plan an effective strategy to tackle the fast-evolving global health crisis.
Interventions before and during Pregnancy to Minimize the Risks of an Overweight Pregnancy

Marloes Dekker Nitert, Kristine Matusiak, Helen L. Barrett and Leonie K. Callaway

Background

Rates of overweight and obesity are high in the obstetric population. In pregnancy, overweight and obesity are associated with increased risk of complications of pregnancy for both the mother and the infant. Obesity results from energy intake exceeding energy expenditure which is not only the result of increased dietary intake but also a host of other factors (fig. 1) [1]. These complications include gestational diabetes mellitus, preeclampsia, instrumental delivery or delivery by Caesarean section in the mother. In the baby, there are increased risks for infants being born macrosomic or large for gestational age, birth injuries, neonatal hypoglycemia and increased admittance to neonatal special care nurseries [2]. Both prepregnancy interventions and interventions during pregnancy are used to prevent complications from arising in the high-risk group of overweight and obese women.

Prepregnancy Interventions

The purpose of prepregnancy interventions is to achieve weight loss. Strategies for weight loss include changes to diet and physical activity but also bariatric surgery for morbidly obese individuals. Dietary interventions do not differ from those employed by the general population and include diets reducing overall energy intake as well as diets where intake of carbohydrates, protein and fat are specifically increased or reduced. Physical activity interventions usually have a larger aerobic exercise component. Pharmacotherapy is sometimes used to support weight loss through lifestyle interventions, but this is not recommended in women trying to conceive. The amount of weight loss achieved by these interventions is unfortunately limited. Barriers for prepregnancy weight loss include lack of pregnancy planning and a lack of acknowledgment of their
overweight or obese status by women. Bariatric surgery is associated with rapid weight loss in the first year after surgery.

Prepregnancy weight loss improves fertility rates, reduces miscarriage and also decreases the incidence of maternal gestational diabetes mellitus and preeclampsia as well as infant macrosomia (table 1). There is limited evidence that undernutrition in the periconception period can have detrimental effects on the health of the offspring later in life [3].

**Pregnancy Interventions**

In pregnancy, the aim of lifestyle interventions is to limit gestational weight gain. Diet and physical activity are the mainstays of the interventions, which take into account pregnancy-related limitations. Limiting gestational weight gain can successfully reduce the incidence of preeclampsia, gestational diabetes and the proportion of infants born large for gestational age or with shoulder dystocia but does not affect the risk for other pregnancy complications (table 1). Studies into altering the composition of the gut microbiome of overweight and obese women are underway [4] since this strategy has been shown to be beneficial in normal-weight women [5].
Conclusions

It is evident that overweight and obesity in the obstetric population increase the risks of complications in pregnancy for mother and baby. While weight loss prior to pregnancy and limiting gestational weight during pregnancy successfully lower some of these risks, the success of lifestyle interventions to achieve this unfortunately is limited. It is as yet unclear if new strategies such as bariatric surgery and altering the composition of the gut microbiome are more successful. If so, the financial implications of these strategies need to be carefully considered in light of the reduction of the short-term and long-term disease burden caused by overweight and obesity during pregnancy.

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Understanding Drivers of Dietary Behavior before and during Pregnancy in Industrialized Countries

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The dietary choices women make before and during pregnancy affect not only their own health and nutritional status but also that of their infant. Dietary change is generally needed to meet the increased nutrient requirements of pregnancy, and while some women make significant dietary changes, others find change difficult. Dietary decisions are known to be influenced by a wide range of factors, some of which are easier to modify than others. The three main factors believed to influence dietary choices are food properties, individual factors and environmental factors. It has also been recognized that dietary decisions are not always rational. Most dietary choices are made quickly and intuitively, and are based on heuristics and food choice strategies developed to make choices easier in different situations. There exists an opportunity to positively influence women’s dietary choices when they first start making changes for pregnancy and are still developing heuristics/food choice strategies. Healthier food consumption choices made in the immediate decision environment (e.g. when planning pregnancy or during pregnancy) may result in longer-term ‘healthier’ eating habits. Consequently, it is important to understand the key modifiable factors influencing women’s dietary decisions before and during pregnancy, so that effective strategies can be implemented to make healthy food consumption choices the simple automatic choice. We present findings from a systematic synthesis of 34 studies which assessed modifiable individual and environmental factors influencing dietary behavior during preconception and pregnancy, and offer suggestions for intervention strategies which may be effective at encouraging healthier dietary choices.

Individual factors which motivated healthier eating and supplement use include: perceived benefits to fetal and maternal health; desire to avoid risk and prevent adverse pregnancy outcomes; greater self-efficacy and perceived behavioral control; lower levels of stress, anxiety and
depression; knowledge regarding dietary requirements and benefits of folic acid and prenatal supplementation, and fewer financial difficulties. Influential environmental factors included: social expectations; information and support from family/friends; advice from healthcare providers, and the food environment including access to healthy food, control over food purchases and meal preparation, and whether food was prepared at home or obtained from an outside source. With this background, potential individual and environment-based strategies to make healthier choices the quick intuitive choice for women could include: framing nutrition information to emphasize the fetal/maternal health benefits of compliance, and/or to elicit positive emotional responses known to motivate healthy behavior; widening use of graphical intuitive nutrition summary indicators on food packaging and for meals purchased from outside sources; developing and encouraging use of food exchange lists which use a traffic light system to ease selection of healthy meals/snacks and simplify meal planning; making healthier options the default choice at restaurants/food outlets and at home, and increasing salience of healthier options to make healthier choices more visible, convenient and accessible than less healthy options. Additional strategies include increasing dissemination of up-to-date evidence-based dietary and supplement recommendations to healthcare providers to support provision of adequate nutrition information to pregnant women and those planning pregnancy, and providing women with automated daily feedback on compliance with dietary guidelines (e.g. via mobile phone applications or websites) to improve their nutritional knowledge, adherence to dietary guidelines and self-efficacy in consuming a healthy diet.

Importantly, while only key modifiable individual and environmental factors are discussed, other factors such as sociodemographic characteristics and physical symptoms associated with pregnancy (e.g. morning sickness, cravings, aversions to certain foods) are known to influence women's nutritional choices and must be taken into account when deciding which strategies are most appropriate and how best to implement them. While many of the strategies outlined are based on insights into human behavior provided by behavioral economics, due to the complexity of dietary decisions and the challenging task of influencing dietary behavior in both the short- and longer-term, a collaborative multidisciplinary approach is required to further develop, test and implement potential strategies. Shaping long-term eating habits by influencing dietary choices made in the immediate decision environment of early pregnancy has the potential to improve maternal and child nutrition beyond the immediate prenatal period.
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