
Integrated Perinatal Health Framework

A Multiple Determinants Model with a Life Span Approach

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- Rationale:** Despite great strides in improving prenatal care utilization among American women, key perinatal indicators have remained stagnant or worsened in the past decade, and the United States continues to rank near the bottom compared to other developed countries. A new approach is needed if we are to achieve improvements in perinatal health.
- Objective:** To propose a new framework that integrates a “life span” approach with a multiple determinants model.
- Method:** We recognize that (1) powerful influences on outcome occur long before pregnancy begins; (2) pregnancy outcome is shaped by social, psychological, behavioral, environmental, and biological forces; and (3) the demography of pregnancy has changed dramatically in the last few decades with more women delaying their first birth. Approaches that simultaneously consider the entire life span as well as multiple determinants may need to be adopted. We propose a framework that integrates these approaches and is supported by the research literature. The life span perspective focuses attention toward the preconceptional and interconceptional periods as targets for intervention in improving perinatal health. The multiple determinants model distinguishes among concepts of disease, health and functioning, and well-being for both women and their offspring.
- Conclusion:** Our intent is to influence how policymakers, public health professionals, clinicians, and researchers approach perinatal health.
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Introduction

Current policy and practice approaches to improving the outcome of pregnancy and perinatal care are based, generally, on an individual-level epidemiologic model of addressing known risk factors. Some efforts have been made to incorporate multiple risk factors into programs of care, but these are still grounded in an intervention model that begins with pregnancy. This, in part, led to the enormous emphasis on early entry into prenatal care. The initial enthusiasm for prenatal care as an all-encompassing strategy, however, has faded as it became clear that the relationship is more complex.¹ Despite great strides in improving prenatal care utilization among American women, there has not been a concurrent decline in indicators of adverse pregnancy outcome. Key perinatal indicators have remained stagnant or worsened in the

past decade, and the United States continues to rank near the bottom for these indicators compared to rates in other developed countries.² A new approach offers the opportunity to achieve improvements in perinatal health.

Rationale for the Framework: Integrating a Life Span Approach with a Multiple Determinants Model

Presented here is our rationale for a perinatal framework that integrates a life span approach with a multiple determinants model. First, some of the most powerful influences on pregnancy outcome are related to influences on women's health that occur long before pregnancy begins. For example, nutritional status may be strongly influenced by childhood practices.^{3,4} To achieve sufficient folate in early pregnancy, nutrition may need to be ensured not just in the few weeks or months prior to pregnancy, but possibly years before childbearing begins. Similarly, although infection during pregnancy is a strong risk factor for preterm delivery,^{5–8} the problem of infections may need to be addressed beginning in adolescence and between pregnancies to be effective in preventing adverse outcomes. While earlier frameworks have shown some recognition

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TIMELINE

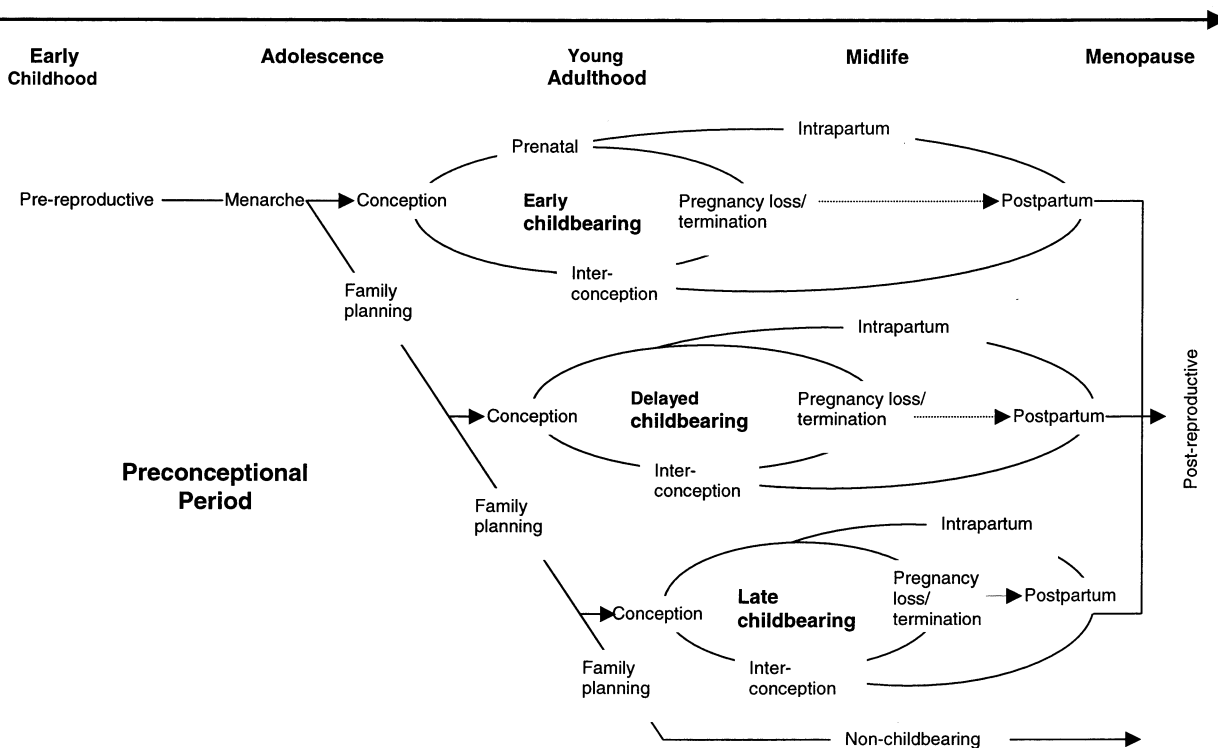


Figure 1. Women's reproductive cycles.

of the importance of the preconceptional period,⁹⁻¹¹ most have limited the scope of their attention and have failed to place preconceptional forces in the context of women's health across the life span. The focus has been on addressing factors in the few weeks to months prior to conception by targeting women who are planning their pregnancies. However, nearly one third of pregnancies in the United States are believed to be unintended (unwanted and/or mistimed).¹² This underscores the importance of promoting a woman's health regardless of her pregnancy plans. A "life span" approach to pregnancy outcome identifies the antecedents of poor perinatal outcome and links behaviors and risks across time, not solely during those periods in which a woman is pregnant.

Second, as in the case of chronic disease prevention programs, efforts to improve the outcome of pregnancy may need to adopt a "multiple determinants" model that integrates the social, psychological, behavioral, environmental, and biological forces that shape pregnancy. Such a model would provide a framework for showing the interrelationships among factors as well as the pathways by which factors might influence perinatal and women's health. Again, the implications for practice and policy are that the integration of these various domains may be an essential step to improve perinatal health.

Third, the demography of pregnancy has changed dramatically in the last few decades,¹³⁻¹⁵ so that ap-

proaches that simultaneously consider the entire life span as well as multiple determinants may need to be adopted to achieve improvements in perinatal outcomes. While teen pregnancy and early childbearing have declined, the adolescent period remains important and retains the particular challenge of addressing issues of early sexual activity. But attention must now be given to the delayed childbearing occurring among older women, who have spent years in the workforce and enter pregnancy with a completely different set of biological and social issues than younger women. A framework for improving perinatal outcomes provides a structure that takes account of these differences.

Women's Reproductive Periods and Definitions

Because the framework proposed here is based on a life course perspective that includes the preconceptional and interconceptional periods, these concepts are examined first. Figure 1 provides a schematic representation of the potential reproductive periods and paths within a woman's life course. All women experience a preconceptional period beginning in childhood and ending either with menopause or the first pregnancy. Each cycle of pregnancy encompasses a prenatal, intrapartum, postpartum, and interconception period. Finally, the length of the interconceptional periods and number of cycles may vary for any given woman.

Each cycle also explicitly models pregnancy loss or termination. This is important to delineate, as sizable numbers of U.S. women will experience a loss or termination of pregnancy. The rate of clinically recognized loss is approximately 12% to 14% of recognized pregnancies.¹⁶⁻¹⁹ It has been estimated that 43% of women will have had an induced abortion by 45 years of age.²⁰

Four hypothetical paths are highlighted here (pictured in Figure 1) because each emphasizes a key issue with regard to reproductive trajectories. This should not be assumed to demarcate any of these paths as normative or optimal. Furthermore, while adolescent childbearing is clearly regarded as undesirable in the majority of American society, there may be cultural and ethnic differences in the meaning of reproduction timing. The first reproductive path describes the trajectory for a woman who becomes pregnant in her early twenties. The preconceptional period is abbreviated, but the interconception periods that follow may be lengthy or short. In the second path, childbearing is "delayed" and so, too, is the first reproductive cycle. In this case, the preconceptional period is lengthy, and future interconception periods will vary but be short if a woman continues childbearing. The third path portrays the experience of a woman who engages in late childbearing (i.e., late thirties through forties). The length of the preconceptional period is extended relative both to women in the first path ("early" childbearing) and the second path ("delayed" childbearing). As there is little time remaining in her reproductive years, the interconceptional period(s) will likely be brief. Finally, the fourth path is that of a woman who never becomes pregnant or gives birth.

As noted above, strategies to improve perinatal health have primarily focused on the prenatal, intrapartum, and immediate postpartum periods, and these strategies have failed to adequately address the impact of child, adolescent, and women's health on maternal and infant outcomes. Regardless of the path taken, a woman will spend the bulk of her reproductive life span in either preconceptional or interconceptional periods. Figure 1 provides the underpinnings on which to build a perinatal health framework that considers all aspects of a woman's life course in addressing perinatal health.

A Multiple Determinants Framework for Perinatal Health

This framework marries a life course perspective, incorporating forces that influence the health of women through successive stages of their lives and their reproductive cycles with a multiple determinants model. Beginning in childhood/adolescence, attention focuses on the influences on health as women mature

and on the forces that have implications for women's health beyond their reproductive period. Childhood and adolescence may represent critical periods for women for a range of behaviors and exposures (e.g., family planning, protection against sexually transmitted infections, nutrition). Integral to the framework are the phases of the reproductive cycle described above.

The perinatal health framework presented is an adaptation of the Evans and Stoddart²¹ model of health determinants. While acknowledging the direct influence that biological, behavioral, environmental, and social factors have on health status, the Evans and Stoddart²¹ model more importantly provides a framework for understanding the interrelations between such factors. It distinguishes among concepts of disease, health and functioning, and well-being, providing a more comprehensive means of assessing health status than that encompassed by traditional health models. Organized in four hierarchical levels, Figure 2 provides a framework for assessing the multifactorial determinants of adverse perinatal and women's health outcomes.

Here, the model has been constrained to the perinatal health arena, encompassing both the woman and her offspring. Following this presentation of the model, how various factors would be conceptualized is examined. The emphasis is on how factors relate to the preconceptional and interconceptional periods, and how multiple factors interact to influence the outcomes.

At the distal level, the framework brings focus to risk factors that place an individual or population at greater susceptibility to proximal risk factors. While having the potential to directly influence individual health status, distal factors are more relevant in terms of increasing or decreasing an individual's predisposition toward developing compromising health conditions, engaging in high-risk behaviors, or being exposed to potential toxins. The primary categories of distal risk factors are genetic factors, the physical environment, and the social environment (Table 1).

At the proximal level of the framework, risk factors that have a direct impact on individual health status are represented by two categories, behavioral and biomedical responses (Table 2). This distinction between the behavioral and biomedical characteristics of proximal risk factors highlights the relationships between high-risk or protective behaviors and a woman's health status, as well the influences of the physiological and biological characteristics of specific health conditions. Psychological factors are included in behavioral as well as biological responses. Both behavioral and biomedical responses provide important targets for intervention.

The interaction between distal and proximal risk factors determines an individual's overall health status. It is the interrelationship between a woman's health status directly prior to conception and the changes and demands of pregnancy that is one of the primary

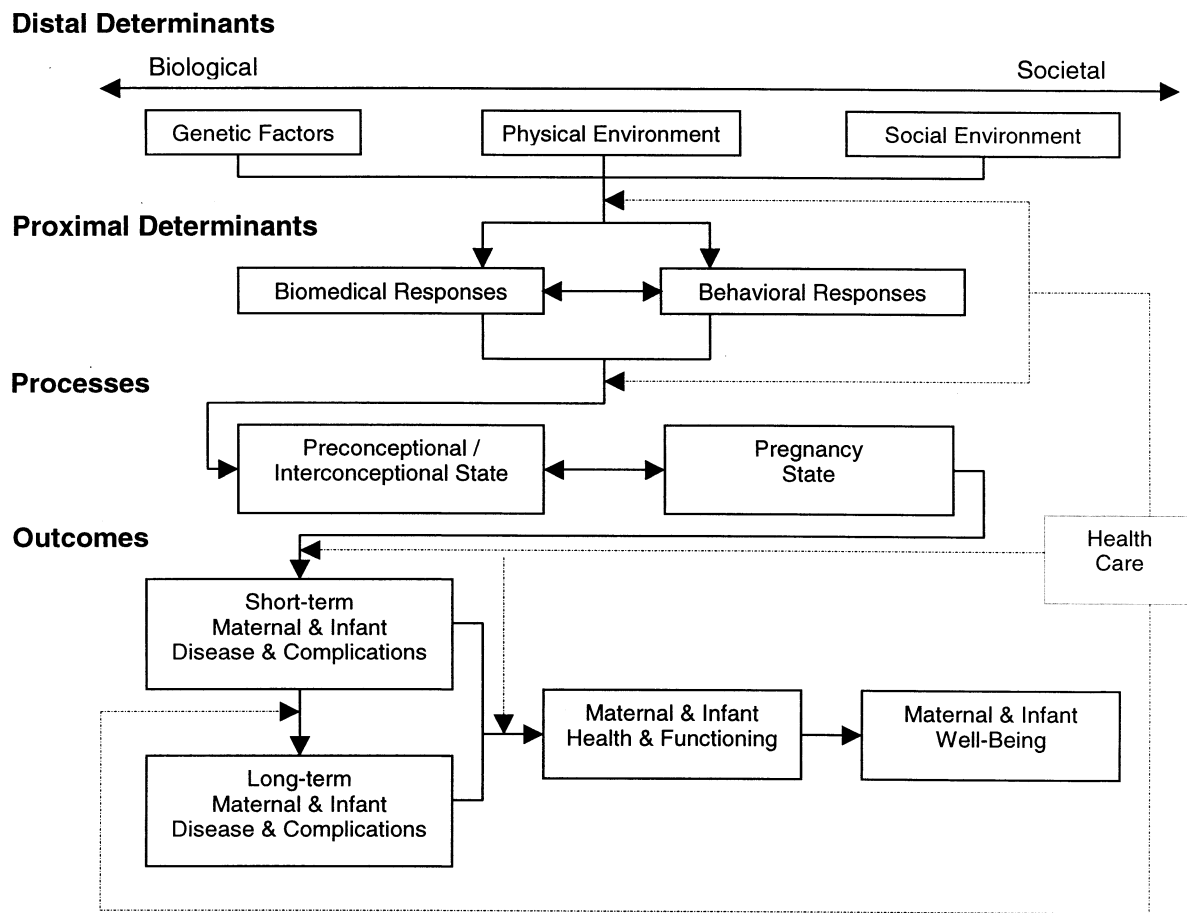


Figure 2. Perinatal health framework.

influences on perinatal health outcomes. Three of the four groups of outcomes from Evans and Stoddart²¹ are included here: (1) diseases and complications; (2) health and functioning; and (3) well-being (Table 3).

Distal Determinants

Distal determinants (Table 1) range from biological to social. At the extreme end of the continuum is the genetic environment. The physical environment falls

Table 1. Distal risk factors

Determinant: genetic environment

Twins and siblings²²⁻²⁷

Intergenerational²⁸⁻³²

Gene-environment interaction³³

Determinant: physical environment

Air pollution³⁴⁻³⁷

Crowding³⁸

Determinant: social environment

Individual³⁹⁻⁵⁰: socioeconomic status, race, stress

Partner, family, social network: social support,^{49,51-60} life events,^{52,61-67} family violence⁶⁸⁻⁷⁷

Neighborhood:^{75,77-90} physical, economic, social, political

Intergenerational^{128-32,91,92}

somewhere between the biological and social ends of the continuum of distal determinants. At the far end of the continuum is the social environment. The distal determinants are the foundation for Figure 2. They exert influence throughout a woman's reproductive life, and may be addressed irrespective of the cycles and paths delineated in Figure 1. The emphasis of prior

Table 2. Proximal risk factors

Determinant: Biomedical responses

Infection^{5-8,93-96}

Nutrition⁹⁷⁻⁹⁹

Chronic disease¹⁰⁰⁻¹⁰⁶

Infertility¹⁰⁷⁻¹⁰⁹

Stress^{44,46,110-118}

Determinant: Behavioral responses

Alcohol use¹¹⁹⁻¹²²

Drug use^{123,124}

Smoking^{99,125-139}

Nutrition⁹⁷⁻⁹⁹

Sexual behavior¹⁴⁰

Assisted reproductive technology utilization¹⁴¹⁻¹⁵¹

Psychologic factors: stress^{48,49,59,60,62-64,66,152-162}; self-efficacy (mastery)^{47,49,153,158}; locus of control^{17,49}; depression and anxiety^{48,49,158,159,161-163}

Table 3. Maternal and infant outcomes

Maternal	Infant
Short-term diseases and complications	Short-term diseases and complications
Hemorrhage	Intrauterine growth restriction
Pre-eclampsia	Preterm birth
Gestational diabetes	Low birth weight
Cesarean section	Congenital malformations
Antenatal hospitalizations	Respiratory distress syndrome
Emergency department visits	Sepsis
Maternal mortality	
Long-term diseases and complications	Long-term diseases and complications
Postpartum depression	Cerebral palsy
Pregnancy weight gain retention	Chronic pulmonary disease
Urinary incontinence	
Risks during subsequent pregnancies	
Cancer	
Osteoporosis	
Maternal health and functioning	Infant health and functioning
Life expectancy	Learning disabilities
Limitations of daily living activities	
Maternal well-being	Infant well-being
Economic stability	Attachment
Positive relationships	School achievement
Autonomy	Employment
Personal growth	
Self-acceptance	
Purpose in life	
Environmental mastery	

frameworks on the perinatal period may have led us to overlook these distal factors, as they are unlikely to be resolved by perinatal interventions alone.

Proximal Determinants

The criteria for selection of the risk factors for the proximal determinants (Table 2) in this framework include consideration of the existing body of scientific knowledge on the factors that influence perinatal health as well as the feasibility of achieving changes in those factors in the U.S. population. First, only factors for which there was scientific evidence of an effect on perinatal outcomes were selected. Second, consistent with the life course perspective, factors were chosen if effective intervention was unlikely to achieve change unless the woman's health during the preconceptional/interconceptional periods was addressed. Third, emphasis was put on those factors that could potentially be addressed directly without requiring major changes in the preceding level of the framework (distal determinants), particularly the social and genetic environ-

ment. While the social environment may have a strong influence on these factors, there may be strategies that address these proximal factors taking account of context but that can be effective without fundamental changes in the social environment. Finally, only factors for which we had an infrastructure and experience in addressing in the pregnant population were included, as these were viewed as more feasible to address.

It should be readily apparent that these risk factors for proximal determinants co-exist (i.e., chronic disease and receipt of assisted reproductive technology [ART] services). It is important to consider the implications of the multivariate nature of the model. Efforts to assess the impact of addressing proximal factors (such as attributable risk estimation) must account for the overlap. Furthermore, interventions to address these factors must address multiple factors simultaneously. It might be necessary to develop a range of strategies to address a particular factor, and the choice of interventions will differ depending on the co-occurrence of other factors.

Processes

Figure 2 includes a "processes" level in the framework that connects the framework to the life course of the woman described in Figure 1. The transition from the preconceptional/interconceptional state to the event of conception and the pregnancy state is explicitly identified.

Outcomes

This framework includes three groups of outcomes (Table 3), each differentiating between mother and infant (including fetus): (1) diseases and complications; (2) health and functioning; and (3) well-being. Short-term diseases have been explicitly separated from long-term diseases and complications, as these groupings are consistent with the way in which perinatal outcomes are grouped for monitoring and research purposes. The intent is to call attention to a broader array of outcomes than is typically considered.

Many of the disease and complication outcomes, such as low birth weight, are already monitored on an ongoing basis, and most are tracked at least periodically. There are some notable exceptions, particularly maternal diseases and complications (e.g., morbidity measured by emergency department visits). However, while the current data system does not capture all of the diseases and complications outlined in Table 3, it is not difficult to identify potential indicator measures of these outcomes. The other two groups of outcomes, health and functioning and well-being, are more difficult to understand, measure, and monitor. Yet these are indeed the outcomes by which success of efforts must ultimately be judged.

Health and functioning could be assessed by global measures such as life expectancy, self-reported health status, and limitation of activities, but a fuller examination of this issue is required. While health is not merely the absence of disease, there are few measures that go beyond the disease paradigm.

Well-being, or life satisfaction, is similarly not easily operationalized. Ryff and Singer¹⁶⁴ have proposed six dimensions of well-being (e.g., positive relationships, autonomy, self-acceptance), but data-based indicators have not been identified for the population. While neither education nor employment may relate to the well-being of an individual, they may serve as indicators of population well-being. Basic necessities of food and shelter can only be obtained if at least some members of the community or family complete an education and obtain gainful employment. Therefore, the evidence that adverse birth outcomes such as low birth weight may lead to deficits in academic achievement and professional attainment in adulthood^{165–167} is cause for concern on a population level.

Health Care

Figure 2 shows that health care can modify the relationships among the various components of the framework. Health care, in this context, is defined as the broad range of activities from primary prevention—society-level programs that could be targeted to preventing unplanned pregnancies among young adolescents—to medical interventions that screen for or treat specific disease processes. The mix of preventive and therapeutic will vary at different levels of the model.

Applications of the Framework

Shown here is how strategies to address selected proximal factors for adverse perinatal outcomes might be informed by this framework. In particular, by examining proximal factors of relatively greater importance for those who engage in either early or late childbearing, the intersection of the life span perspective (Figure 1) with multiple determinants (Figure 2) is illustrated.

Nutrition. This proposed perinatal framework leads to interventions that address nutritional factors in the periods outside of pregnancy. While folate supplements have received considerable attention with regard to congenital anomalies, recent surveys suggest continued efforts are needed. In a 1998 survey, 68% of women reported ever having heard of or read about folic acid, while only 29% of women reported folic acid supplementation prior to pregnancy.¹⁶⁸ Less than half of U.S. adult women consume diets containing 100% of the recommended dietary allowances for folate with little variation by age.¹⁶⁹ This is a clear example of a factor for which there is evidence that deficiencies cannot be effectively addressed during pregnancy and why a

framework that explicitly considers the periods outside of pregnancy is needed. Except for the recent mandate to fortify grains and cereals,¹⁷⁰ folate supplementation has been an issue largely consigned to “pregnancy planning.” Yet the high rate of unintended pregnancy in the United States¹² necessitates targeting women who are not planning pregnancies for intervention.

Infection. The rates of all sexually transmitted infections are much higher in the United States than in any other developed country, and the rates of many sexually transmitted infections have been increasing.¹⁴⁰ Rates of sexually transmitted infections as well as other reproductive tract infections are highest among poor women and minority women,¹⁴⁰ the same groups at high risk for adverse perinatal outcomes. While sexually active women of all ages are susceptible, two thirds of all cases occur in persons aged <25 years. The increased burden of infection for young women is related to both higher-risk behaviors and biological differences.¹⁴⁰

These infections, even if treated, may lead to pelvic inflammatory disease and may cause tubal damage resulting in infertility. This means that infection years before a woman intends childbearing may affect the health of the woman and infant. Research on infections in pregnancy also suggests the need for strategies that target the problem of infection outside of pregnancy. Treatment of infections during pregnancy may reduce the risk of adverse outcomes, but results have not been consistent.^{93–96} Reasons for this failure to achieve improved outcomes may include recurrence or persistence of the infection. Goldenberg et al.⁵ have hypothesized that some women may suffer from chronic persistent infections, seemingly asymptomatic, that are harbored in the uterus between pregnancies. These possibilities suggest, again, that the perinatal period may be too limited to address these issues. A model that explicitly includes the periods outside of pregnancy is needed to develop approaches to prevention and treatment of infections.

Chronic disease. Chronic diseases, taken as a group, affect substantial numbers of women.^{171,172} Most chronic conditions increase in frequency with age. Furthermore, the longer a woman has had a chronic condition, the more likely it is that her health has been adversely affected. The postponement and continuation of childbearing by women into their thirties and forties^{13,14} underscores the importance of addressing chronic diseases in the context of pregnancy-related care and services.¹⁷³ Finally, the burden of chronic disease falls disproportionately on two overlapping subpopulations of women at increased risk for adverse perinatal outcomes: poor women and minority women.¹⁷³ For these women, health may decline with age, such that earlier childbearing is associated with fewer adverse outcomes.^{39,174–177}

While chronic diseases can be managed during pregnancy, a woman's health and that of her fetus may remain compromised. Particular treatments may be teratogenic and/or hazardous to the mother in pregnancy and need to be modified for women who are pregnant or at risk for conception. Pregnancy may also exacerbate chronic diseases.¹⁷⁸⁻¹⁸⁰

Interventions that increase protective behaviors, such as proper nutrition and exercise, as well as those that seek to reduce negative factors, such as smoking and stress, are important steps toward reducing the incidence and sequelae of chronic conditions and concurrently improving perinatal outcomes and women's overall health. Adolescents may be a critical group to target. There is growing evidence that healthy behaviors adopted in adolescence (e.g., physical activity, diet) continue at least into young adulthood.^{3,4} Misra et al.¹⁷³ have explored potential opportunities where women's and perinatal health can intersect, including broadening strategies aimed at improving perinatal health to emphasize a woman's health regardless of childbearing status or plans and using perinatal health care as a bridge to ongoing care for women. Therefore, chronic disease is another factor for which strategies may be more effective if conceptualized based on a framework that integrates the life course and a multiple determinants model.

Assisted reproductive technology. While ART may increase risk in singleton gestations,¹⁴¹⁻¹⁴³ the high rate of adverse outcomes is largely a consequence of the increased rate of multiple gestation pregnancies. While women utilize ART across their life span, women who initiate childbearing in their late thirties and forties are more likely to experience infertility and to utilize ART services.¹⁰⁷ Women who engage in late childbearing, as discussed above, are also more likely to have chronic conditions and there may be interactions with ART.

One strategy might be to develop clinical practice guidelines to limit the number of conceptuses implanted or to monitor ova released. However, such approaches may not be entirely successful. Using a broad framework, the focus shifts to the antecedents of infertility, which may be far removed. This would require attention to women's health prior to conception, perhaps even reaching into adolescence and childhood. Among the known causes of infertility, the single greatest contributor is a sexually transmitted infection.¹⁰⁷⁻¹⁰⁹ The prevention and treatment of infections prior to and between pregnancies, particularly in young women who may be years away from initiation of childbearing, would be one strategy to improve perinatal health that would follow from examination of ART within our proposed framework. This framework provides the structure to conceptualize and develop strategies that take into account these multiple determinants of pregnancy outcome.

Conclusion

This proposed model focuses attention on risk factors that influence perinatal outcomes but that occurred prior to and between pregnancies. We argue in favor of creating a system of health care that integrates the multiple determinants of perinatal outcome across the early life span of women. This review concludes that improvements in perinatal outcomes, among both women and their infants, have plateaued for two major reasons. First, interventions are focused primarily on the most proximal of determinants (i.e., concurrent risk factors for poor pregnancy outcomes). Second, the fragmented healthcare system segments care during the pregnancy period from the preconceptional and interconceptional periods. Overcoming these impediments will require bold and innovative changes in both the public health and medical care arenas.

Public health has a long history of addressing health issues from a broad perspective that considers biomedical as well as social factors. Furthermore, prevention has long been the hallmark of public health practice. However, even progressive public health practitioners have rarely undertaken prevention programs in which the benefits are as distant as this framework outlines. We are hopeful, however, that recent efforts to intervene in childhood to alter adult cardiovascular disease risk¹⁸¹⁻¹⁸⁴ will encourage public health leaders to be innovative and to consider funding programs that address perinatal health in new ways. This could include spending money budgeted for "perinatal health" on programs that focus on childhood behaviors related to nutrition, sexual activity, and smoking. The expansion of funding in this area would be welcome, but we also encourage public health agencies to be bold and to consider changing existing funding structures for future gains. Public health leaders can also adopt this framework by lobbying for public financing of the gaps in the healthcare system, specifically for coverage of comprehensive care for women who are not pregnant.

Attention to preconceptional and interconceptional health, as outlined in this framework, also requires change in the delivery and financing of medical care. Preconceptional health risks must be addressed while women are still in the care of pediatric and adolescent medicine specialists. However, at present, there is no recognition of a role for pediatric providers in preparing girls for their later pregnancies. Still, just as pediatric providers are beginning to appreciate the ways in which children's health may influence adult chronic diseases, the link between children's health and later perinatal outcomes must begin to be given credence. In a recent article, Hall¹⁸⁵ proposed that pediatricians can play a role in the primary prevention of preterm birth not only by emphasizing avoidance of adolescent pregnancy, but also by promotion of good nutritional status and avoidance of smoking, illicit drugs, and genital

infections. This might be realized through changes in the schedule of anticipatory guidance and prevention guidelines as well as through recognition of these services as reimbursable by health insurance and publicly funded programs. As shown in this review, however, improving perinatal outcomes also requires attention to the current needs of older mothers who may be under the care of an internist. Improving pregnancy outcomes necessitates the linkage of an even broader array of healthcare providers embracing a life course perspective with regard to perinatal health.

Similarly, family planning and prenatal care have too long been the domains of separate practitioners, delivery sites, and financing mechanisms. Public financing for both types of care has made such care available to many low-income women. But there is often a gap in care for women as they transition between these care providers after conception. The larger gap, however, is with regard to public financing of "nonreproductive" healthcare services. While family planning explicitly provides care to nonpregnant women, the scope of that care is limited. Prenatal care is necessarily limited to pregnancy and, therefore, cannot address the woman's health prior to pregnancy. The population needs care that does not recognize these boundaries but rather provides for women across their reproductive life span. Some would also suggest that the end of a woman's reproductive life span should not be another boundary or would argue that men as well as women need comprehensive care regardless of life stage. Philosophically, we agree but favor incrementally working toward such a goal by establishing evidence for this small step forward.

In developing this perinatal framework, we have built on the work of others in the fields of multiple determinants of health and in thinking about health across the life span. We do not expect that this effort will be the final framework, but view our work as a contribution to an ever-evolving set of ideas.

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