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THE USE OF COST-EFFECTIVENESS AS A FRAMEWORK FOR ASSESSING ALTERNATE IRON SUPPLEMENTATION AND FORTIFICATION STRATEGIES: THE JAMAICA CASE (1992)

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A FRAMEWORK FOR ASSESSING THE COST-EFFECTIVENESS OF ALTERNATE IRON SUPPLEMENTATION AND FORTIFICATION STRATEGIES: THE JAMAICA CASE (1992)

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1. SUMMARY

The use of cost-effectiveness as a framework for program assessment and planning is demonstrated in this report. Using the example of iron deficiency control programs in Jamaica, the cost-effectiveness of current versus redesigned programs is compared. Two most commonly implemented iron deficiency control interventions are included: iron supplementation for pregnant women and fortification of cereal flour. The analyses are done using existing data, with small additional primary data collected on key variables. An objective of this analysis was to develop an approach that can be used in other countries, or to assess other options in Jamaica, without the need for extensive primary data collection.

In the example on iron supplementation for pregnant women, the national program in effect during 1992/93 is compared with a modified program in which improved supplies, elimination of universal screening, and provision of free supplements only to the high risk are included. The results show that of the 60,000 pregnant women eligible for iron supplementation, approximately 26,000 were benefiting from iron supplementation in 1992/93. With the modifications proposed, the program would benefit another 16,000 women - all of them government clients. The costs to government can be reduced from the estimated US$4.32 per woman benefitted to US$1.42 per woman benefitted. Participant costs can be reduced by half. The example of the iron fortification program demonstrates trade-offs in higher costs and higher bioavailability of newer fortificants such as iron-EDTA when compared with less readily absorbed iron currently in use.

The study raises other strategic issues such as the lack of interventions directed to benefit infants and young children. This points to the need for a mix of interventions that would include fortification of food consumed by weaning age infants, and supplements not only for women but for infants and young children as well. While dietary deficiencies appear to be the primary cause of iron deficiency in Jamaica, in other countries, malaria and intestinal parasites may be important etiological factors, and comprehensive intervention packages to combat iron deficiency will need to address these components as well.

2. INTRODUCTION

2.1 Background

Iron deficiency - the world's most widely prevalent nutritional disorder - is now recognized as an important constraint to utilizing the full potential of human capital in economic growth and national development (World Bank 1994). Negative effects of iron deficiency and anemia include excess maternal and newborn mortality, limited learning capacity, impaired immunity against infections, slower growth and development in children, and lowered working capacity and output among adults (WHO 1994). A large proportion of the population in Jamaica in all age groups suffers from varying degrees of iron deficiency and anaemia. The deficiency causes severe adverse affects in all segments of the population. Women during pregnancy and young children (under 24 months of age) are particularly vulnerable. See Table 1. In a recent assessment by the World Bank (1994), anemia ranked in the top ten disease conditions contributing to the national burden of disease as measured by DALYs (Disability-Adjusted Life Years) lost, among women in the 15-44 year age group, and among both, girls and boys in the

5 - 14 year age categories[1]. The available evidence suggests that anemia is caused primarily by a deficiency of iron in the diet.

Fortunately, practical solutions exist to address the problem of iron deficiency on a large scale and in the near term. Iron supplements for pregnant women, and fortification of foods with iron, are two commonly used strategies. Their potential cost-effectiveness compares favorably with other interventions in the health sector (Levin et al 1991, World Development Report 1993). With the encouragement of the Caribbean Food and Nutrition Institute, the Government of Jamaica has for over a decade, implemented distribution of iron tablets to pregnant women attending prenatal clinics, and fortification of wheat flour (Simmons, 1980). However, recent information on iron status in Jamaica suggests that iron deficiency remains a problem of significant proportions despite some evidence of improving trends (Simmons 1994). Clearly, the potential impacts of these strategies are not being realized. Given the serious resource constraints within which program solutions must be developed, it has become necessary to consider both the costs and the effectiveness of alternate strategies taking into account local epidemiologic, infrastucture and economic contexts.

In the remainder of this section, we describe the methodology used to estimate cost-effectiveness of current and improved models of supplementation and fortification. Details of the costs and effectiveness of both interventions are in sections 3 and 4 respectively. Overall conclusions and recommendations are in section 5.

2.2 Study Objectives and Approach

The question addressed in this analysis, is whether the cost-effectiveness of existing strategies can be improved in order to achieve more rapid reductions in iron deficiency at reasonable cost. This paper draws from cost and effectiveness assessments undertaken in collaboration with the Caribbean Food and Nutrition Institute (CFNI) and University of West Indies in 1992-1994 (Blackwood-Harriott 1994, Jackson 1993, and Simeon 1993). These analyses form part of a series of cost-effectiveness studies supported by the U.S. Agency for International Development (USAID) through the Latin America Health and Nutrition Sustainability program, aimed at increasing investments in nutrition and obtaining greater benefits from nutrition investments in the region (Sanghvi et al 1992).

The cost-effectiveness framework has been used extensively and applied to other types of health programs (Mills 1993, Phillips et al 1987, Creese and Parker 1991, World Bank 1993). Only recently is this approach being applied systematically to nutrition interventions (Sanghvi et al 1994 & 1995, Phillips et al 1994). In this study, we assess the cost-effectiveness of the supplements and fortification programs as they functioned in Jamaica in 1992, and compare ongoing programs with proposed improvements. Since the target populations of the two

[1] DALY estimates for iron deficiency probably underestimate the broader, less direct impacts such as impaired cognitive development and low educability of school-age children.

interventions are different, they cannot be easily compared. Oral iron supplements are designed to cover greatly enhanced daily needs of pregnancy, for a limited period of time. Fortification is designed to provide the national population with a small daily dose of iron for the long term, to make up deficits in daily diets and prevent any depletion of body stores. The interventions are complementary and generally both types of programs are needed. This is the case in industrialized countries where the vast majority of foods are iron fortified plus iron supplements are a standard component of prenatal care. In this analysis, therefore, the two types of interventions are not compared but rather two models of implementation within each intervention type are compared. First, each program is assessed for cost-effectiveness, and then current implementation models are compared with alternative models. The alternative program models were developed on the basis of findings from our assessment of 1992/93 programs, recommendations from WHO (1994), and the literature on supplementation and fortification[2].

Three steps are involved in estimating **cost-effectiveness**:

1. Measurements of the effectiveness of activities (involving decisions about indicators, measurement techniques and data sources).
2. Costing out the activities (involving decisions about what costs are legitimately attributable to the activities, time periods to be included, etc.).
3. Combining the costs with effectiveness in a useful way (involving decisions about indicators and their numerators and denominators).

The present study relied on available data and the only **effectiveness** indicator for which data were either routinely collected or relatively easily gathered in some form, was access to and consumption of iron. For supplementation, we use the number of women who consumed supplemental iron during pregnancy. This includes women who obtained iron supplements from public or private sources, and who continued to use them. For fortification, we use the measure: number of individuals who without the fortification program would remain deficient in their daily consumption of iron from the rest of their diet. FAO/WHO (1988) recommended levels were used to assess adequacy.

The **cost** of each program model and intervention was determined using the following broad approach:

1. Identifying all the ongoing or maintenance, but not start-up activities undertaken by all parties as part of the program.
2. Identifying the types of resources required to implement these activities such as personnel time, equipment, storage space, materials etc.

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[2]In 1994/95 the programs were restructured significantly, partly in response to the findings of this assessment. It was not possible to include the currently implemented program models as they have been in start-up phase. The recurrent costs and effectiveness measurements during start-up would not be accurate representations of mature, steady state programs.

3. Estimating costs of these resources. For recurrent costs, we use expenditure records or inventories and price lists to determine costs for the year of the study. For capital costs, key equipment and buildings were listed and their current value determined.

An attempt is made to value all the resources and to value them in terms of their opportunity or economic cost (i.e. their value in the next best alternative use). This means, for example, valuing the resources which were given as gifts and labor which was voluntary. Participant costs (e.g. costs incurred for travel, lost work time etc.) as well as the provider costs were measured. In those cases where iron interventions have been added to existing programs and delivery systems, only the costs of resources used for the additional intervention were costed out - i.e. the marginal cost of iron supplementation and fortification activities, rather than the average costs that include other components of antenatal care or wheat flour production, respectively.

Cost and effectiveness indicators were developed from the point of view of those investing in the programs. Government and clients of antenatal services and consumers of wheat flour are the key entities paying for the programs. For government, the issue is maximizing the numbers of key target groups protected from the risk of iron deficiency anemia, keeping budgetary limitations and competing health priorities in mind. For clients and consumers, it is reducing participation costs. Indicators that reflect these concerns are developed and presented for the current and alternative models for comparison.

3. SUPPLEMENTATION

The goal of the Ministry of Health's iron supplementation program is to provide sufficient iron through oral supplements to fulfill the daily needs of women during pregnancy. All women in Jamaica during the second half of pregnancy, regardless of socio-economic status, are considered at risk for iron deficiency based on high prevalences of anemia found in surveys and evidence of low dietary iron consumption relative to needs. International protocols call for universal, daily consumption of two iron tablets (120 mg./day) starting in the 20th week of pregnancy for all women (WHO 1994). The target population for this program is an estimated 60,000 pregnant women in Jamaica[3]. In this section, we first describe sources of data used for the analyses, followed by a description of how the program functions and how it can be modified. Then we provide estimates of effectiveness of current and alternative implementation models; and finally, the costs and cost-effectiveness of the current versus alternative models.

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[3] Crude birth rate per 1,000 population = 25 * 2.4 millions in mid-1992 (WDR, 1994) = 60,000 births. Another estimated 15,000 women enter pregnancy the same year (though delivery takes place in the subsequent year) for a total of 75,000 pregnant women in 1992. However only those in the 20th or more weeks of pregnancy were eligible for iron supplementation.

3.1 METHODOLOGY

3.1.1 Effectiveness estimates and program description

Information on the policies, scope and functioning of the program was obtained from the Ministry of Health. An exit survey with 232 mothers and 12 health providers was conducted to gather data on prenatal attendance, screening activities, prescription and distribution of supplements, availability of supplies, compliance and side-effects (Jackson, 1993). Faculty of the Nutrition Department, University of West Indies (Jackson) conducted the health center surveys in the first quarter of 1993. The survey was cross-sectional and employed a multi-stage sampling of health centers. Health centers in the parishes of Kingston, St. Andrew, St. Catherine and St. Thomas (a list of which was obtained from the Ministry of Health) were stratified into urban and rural. Every 12th and 8th health center was chosen in urban and rural parishes respectively, to generate a total of 6 urban and 6 rural health centers. Questionnaires were administered to 12 persons with responsibilities for the maternal and child health services (either the public health nurse or midwife), and to 232 pregnant women attending urban and rural antenatal clinics at health centers.

Discussions with Ministry of Health personnel, visits to Island Medical Stores and public and private pharmacies provided information on protocols for antenatal treatment, the availability of supplements, and the costs and procedures involved in testing. The Island Medical Stores is the Ministry's central medical supplies procurement and distribution agency.

We use the Monthly Clinic Summary Report (MCSR) to estimate the number of pregnant women attending government antenatal clinics at health centers, after minor adjustments for biases and misreporting from some areas.

3.1.2 Program and participant costs

Faculty of the Mona Institute of Business of the University of the West Indies, Mona Campus conducted the cost analysis. Based on a detailed description of the program activities, a list of inputs used at each stage of the program's functioning was developed. Using salaries, prices paid to obtain supplies or replacement costs as appropriate, the value of program inputs was calculated and categorized into the following: personnel costs, cost of screening (hemoglobin analysis) and supplements, and other operational costs (vehicles, education materials and equipment).

The aim of the cost exercise was to measure the costs to the health service and the cost to patients or participants, of iron supplementation during pregnancy. It does not include costs of activities for routine antenatal care, that would be incurred in the absence of iron supplementation. Included are: the costs of hemoglobin tests, procuring and dispensing iron tablets, and counselling and education on iron supplements, as part of routine prenatal care. Government cost estimates were obtained from data collected through interviews with prenatal clinic staff at government health clinics, hospitals and in private practice, visits and telephone

interviews with government stores and private sector warehouses, and public and private laboratories. Ministry of Health personnel were consulted and examination of government triennium estimates for health sector expenditure were undertaken. Total staff at health center and hospital posts, and salary scales in the MCH were obtained from the Ministry of Health. The salaries, prices and time devoted by the various categories of health workers to antenatal anaemia screening counsel and prescription was estimated from personal interviews.

Antenatals are referred to doctors only in those cases where the nursing staff is unable to treat presenting conditions. These costs may be slightly underestimated as costs for doctors services (when required) are not included. However, doctors rarely see antenatals and this is not likely to be a serious error.

Anaemia screening and (prophylactic or therapeutic treatment) is complementary to a range of services such as routine screening for risk factors of pregnancy (high blood pressure, VDRL screening, etc.), immunization, and family planning. Costs need to be shared - a potentially hazardous procedure. Cost data are normally aggregated under broad program headings and attempts to disaggregate them are at best approximate.

In the present analysis, the time of staff spent on the following activities was estimated by interviews and observations: taking and analyzing blood for hemoglobin analysis, writing a prescription, dispensing iron supplements, procuring and maintaining supplies of iron supplements, and education/counselling of mothers. Costs of the space, equipment and materials used for the analysis are also included. As almost no supplies were found at the health centers, storage costs of supplements are included only at hospitals and Island Medical Stores.

Participant costs, including transportation/travel costs paid by the patient, waiting times at clinics, fees paid for tests and private doctors, and costs of purchasing iron supplements, were obtained from a survey of women attending government health clinics (Jackson, 1993) and interviews with staff at public and private prenatal clinics. Participant transportation costs were estimated based on rates obtained from the public transport sector and on the fact that the 344 health centers are dispersed such that most participants would not have to travel more than 5 miles to reach a facility. In Jackson's survey (1993), socio-economic profiles revealed the health center clients to be poor. They were therefore assumed to be earning the national minimum wage of J$250 weekly (US$11.3 per week, or US$0.28 per hour, based on a 40 hour work week) and this was the value placed on their time. Telephone interviews and checks at selected pharmacies and health insurance companies gave indicators of private sector prices for 1992. Annex 1 contains unit prices for key materials and rent.

3.2 PROGRAM DESCRIPTION

An estimated 95 percent of all pregnant women receive antenatal care from government or private clinics, at least once during pregnancy (World Bank, 1994). An analysis of household data collected in the 1989 Standard of Living Conditions survey, and data from MOH reports suggest that approximately 15 percent of those who participate in antenatal clinics go to private

providers. Of the remaining, approximately 82 percent go to government health centers, and 18 percent use hospital-based antenatal clinics. The MOH policy includes provision of supplements for pregnant women as an integral part of the maternal and child health program. It operates through approximately 344 government health centers which are widely dispersed throughout the island with only a small percentage of the population being more than five miles from a facility (McFarlane & McFarlane 1987). In addition, antenatal clinics are held at the 20 government hospitals. According to the manual of norms and procedures for primary care (MOH, 1982), all pregnant women were targeted for supplementation with iron and folic acid[4]. All pregnant women were meant to be tested for hemoglobin and receive at least one tablet per day for each six-week period between antenatal visits. Prescriptions and supplies ar given for six weeks at a time until the next prenatal visit. The most common types of supplements for pregnant women were ferrous sulphate, ferrous fumarate and ferrous gluconate, and mostly in tablet form. In 1992/93, almost all supplies were purchased by government; small amounts may donated from time to time. The government's central medical store - Island Medical Store (IMS) - is the supplier for health centers. Every three months, health center and hospital staff estimate medical supplies needed, including iron supplements, based on numbers of prenatal clinic attenders. The driver and vehicle taking in the request to IMS usually return with the supplies. In this paper, the "program" consists of attendance at antenatal clinics, screening for hemoglobin, obtaining supplements, and compliance. This refers to all pregnant women in Jamaica, including those that attend government health centers or hospitals, as well as antenatal clients of private doctors. In the following sections the current status of each major activity is described first, followed by the alternative program[5].

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[4]Folic acid is a B vitamin needed for production of hemoglobin and a lack of this causes anemia.

[5]Modifications in the existing program were identified from problems noted in the 1992-93 assessment of the program, recommendations from the WHO guidelines (1994) and recent literature on compliance and other key program attributes. In mid-late 1993 and 1994, MOH restructured the iron supplementation program in important ways: (1) All pregnant women are still expected to be screened but with a new, simple method called "Hemocue" hemoglobin blood testing system and 70 percent of health facilities are estimated to have been equipped; (2) pregnant women receive a six-week supply of one daily dose of iron if their hemoglobin tests over 10 g/dl, and are given a supply throughout pregnancy if their hemoglobin is below 10 g/dl; (3) iron supplies were significantly improved. They are no longer a prescribed item and do not go through Island Medical Stores. The central warehouse directly transports them to Health Departments in parishes; (4) a "linkage" system of referral was introduced on a pilot basis to strengthen referrals between primary and secondary care institutions, and is now being expanded island-wide.

3.2.1 Attendance at antenatal clinics

The attenders are an aggregate of those seen at government facilities (health centers and hospitals) and those who see private physicians. Using MCSR national data, it can be estimated that a majority of pregnant women make antenatal visits to government health centers. Of those not attending a government health center, some receive family or traditional care in pregnancy and others attend hospital casualty (emergency) and outpatient departments. In the Kingston area, for example, coverage by health centers is particularly low because the island's principal maternity hospital provides antenatal services (and attracts deliveries) from the city and neighboring rural areas. According to the World Bank (1994), FIVE percent of all pregnant women do not receive antenatal care. Data on private/public participation and quality of prenatal services from the 1989 SLC survey and Peabody et al (1994), respectively, suggest that for antenatal care, of those receiving any antenatal care, 85 percent seek government services, and 15 percent go to private doctors.

Approximately 82 percent of the estimated government clients (39,513 reported by MCSRs in 1992) use health center clinics for antenatal care. The remainder use hospital based clinics for antenatal care.

Alternative program. We assume that the proportion of women using government health centers, government hospitals and private clinics will not change, as the modifications do not imply any basic changes in the quality of the entire antenatal services package, but rather only relatively small changes specifically related to iron supplementation.

3.2.2 Screening

aLL Women coming for their first prenatal visit were meant to have a blood test to determine their haemoglobin status. Previously, blood specimens were sent for analysis to a central Government Laboratory in Kingston. Often, blood samples hemolyzed before being tested. Also, a wait of 4-6 weeks was often experienced, which was too late for supplementation to be effective and required a system of repeat appointments with the client. It was decided to test for hemoglobin level on the spot by the copper sulphate method. The proportion of women making their first antenatal visit to a health center who were tested for hemoglobin level and for whom test results were reported in MCSRs, has varied very widely year by year (for example, 45 percent in 1983, 13 percent in 1989) and parish by parish (for example, 16 percent in Trelawny and 65 percent in St. Mary in 1991). Variations among health districts have probably been even greater. Omission of testing has been largely attributed to shortage of staff time and of supplies (mentioned in this context since at least 1980). Only a percentage of pregnant women have their blood taken for analysis during their visits at the MCH centers. The blood samples were sent to government hospital laboratories for analysis. Some women who were seen at government clinics were referred to private laboratories for tests.

According to Jackson's exit survey at health centers (1993) that included interviews with antenatal clinic attenders, and nurses and midwives providing prenatal services, approximately

half of the pregnant women had their hemoglobin tested at government health facilities - mostly at hospitals. No health center in the first quarter of 1993 (time of survey) was found to have screening equipment for measuring hemoglobin. According to the women surveyed, 65 percent reported being tested. Of those tested, 68 percent were at government facilities and 32 percent were tested at private laboratories. All private clients and hospital clinic attenders appear to have been tested for hemoglobin.

Alternative program: The 1992-93 assessment suggested that routine, universal screening for hemoglobin using the methods prescribed in 1992-93, at all health centers, was not feasible due to logistics and resources constraints. In addition, WHO guidelines (1994) recommend that in countries where the majority of pregnant women are iron deficient (low hemoglobin or other measures such as inadequate intakes), universal supplementation, without screening, should be undertaken. As shown in Table 1, in Jamaica 52 percent of pregnant women are estimated to have deficient hemoglobin levels and over 80 percent are estimated to have iron-poor diets. WHO notes that there is no simple, reliable, and inexpensive laboratory method available to identify individual women in need of iron. Furthermore, "in most developing countries, about 40 percent of the women and children are anemic and virtually the whole population in these categories is likely to be iron deficient.....In resource-poor settings, where routine laboratory testing with hemoglobin or hematocrit is not feasible, clinical signs can be used to screen very high risk women and children prior to the occurrence of life-threatening complications or the need for transfusion" (WHO, 1994). To estimate the improvement in program efficiency resulting from this change, universal hemoglobin testing was dropped from the proposed alternative program, and replaced with screening for clinical signs, and referral for suspected severe anemia cases.

In the alternative program, hemoglobin is tested only on referrals to the hospitals and for those identified as have severely anemic clinical signs. There are no good estimates of the number of women who are likely to be identified through screening for clinical signs, as needing a hemoglobin test. According to recent estimates (Simmons 1994), approximately six percent of all women in the Caribbean are estimated to have hemoglobin levels below 8g/dl. Providing a margin for false positives, we assume that 10 percent of women seen at government health centers and hospitals will be referred, on the basis of clinical signs, to be tested for hemoglobin to determine if other therapeutic measures such as replacement therapy (transfusions) may be needed. This is probably conservative, as most of the five percent who do not receive any antenatal care are likely to constitute the bulk of the estimated six percent who are severely anemic. In the alternative program, it is assumed that all private clients will continue to be screened.

3.2.3 Supplementation

All pregnant women attending government health clinics either at health centers or hospitals were expected to receive supplements. In practice, government supplies of iron at health centers were found to be erratic. In Jackson's survey conducted in early 1993, of 12 randomly selected urban and rural health centers; only one had stocks on hand on the day of the visit. Nurses and

midwives reported serious shortages of iron supplements. Irregular and inadequate quantities were received from central supplies. The health center staff estimated that during the preceding six months approximately half of all clients purchased all their supplies privately, and another 40 percent sometimes purchased and sometimes received free supplies from health centers.

Of the women surveyed by Jackson (1993), 57 percent reported that they had been prescribed iron, and of these 19 percent had been given some supplies by the health center. The others purchased their supplies from a private pharmacy. It is likely that a high proportion of hospital clients received supplements, and we assume 80 percent did. This is based on data from interviews with Island Medical Stores, where it was reported that the bulk of supplies of iron for 1992 (estimated to be sufficient to cover 94 percent of national needs) were sent to public hospitals. Approximately half of all hospital clinic attenders receive free iron supplements, and the other half purchase them. Considering the higher socio-economic status of clients using private doctors, and the low cost and widespread availability of iron supplements private clients are assumed to have been prescribed iron supplements and all are estimated to have purchased them.

With reference to private sector demand and supply, in general, there appears to be a high level of awareness of the benefits of iron supplements. Although this has not been systematically documented, over 80percent of the women interviewed at government health centers knew about the importance of iron; approximately 60percent heard about it from multiple sources including the media (Jackson 1993). There is a large market for tonics and tablets containing iron with multiple suppliers and a large variety of products costing from 50 Jamaican cents to 4.5 Jamaican dollars per dose (.02 to .20 US $).

Alternative program: Lack of systematic counselling and adequate supplies at health centers was clearly a serious constraint for achieving high coverage. A better system of training and procurement and allocation among health centers and hospitals is key to improved effectiveness. This will need initial start-up investments in: redesigning the system, training or orientation of nursing staff and procurement and pharmacy managers; and small continued investments in monitoring of the counselling and supply system. The resulting increase in the number of women counselled and prescribed iron is assumed to be from 57 percent in 1992/93 to 90 percent. Of the 90 percent covered, 20 percent are estimated to receive free supplies from health centers, with 80 percent required to purchase them from pharmacies. Eighty percent of all hospital users are expected to continue to be prescribed supplements with approximately half receiving free supplies. No change in prescription of supplements for private clients is anticipated. We expect no change in dosage, the total number of supplements procured by MOH or the cost of supplements.

3.2.4 Compliance (procurement and consumption of iron supplements by women)

An important factor suggested as a determinant of effectiveness of iron supplementation programs for pregnant women has been compliance. Here the term "compliance" is used to mean procurement (through purchases or trips to health facilities for free supplies) and

consumption of iron supplements after they have been prescribed. Although the main reason cited by authorities has been adverse side-effects of iron (nausea, constipation, dizziness), a recent review of literature finds that lack of supplies and inadequate motivation and information were most often underlying reasons for low compliance (Galloway and McGuire, 1994). Costs incurred by participants can be a critical factor as well.

In the survey of a sample of 232 women attending prenatal clinics at health centers (Jackson, 1993), 57 percent stated that they were prescribed an iron supplement at health clinics. Another 9.5 percent of women obtained supplements without a prescription. In all 65.6 percent claimed to have obtained and used supplements. Of private clients, an estimated 96 percent obtained supplements and used them.

In terms of consumption, 90 percent of all women surveyed reported no side effects and are assumed to have continued taking the supplements they procured. Nausea was reported by seven percent, dizziness by five percent of the total sample.

Alternative program: With improved training, education to generate consumer demand, and an improved supply system we anticipate an increase in compliance[6]. A stronger and more focused education program, including training, print and broadcast media - has been included in the alternative program. The target audience includes private providers found to be deficient in the education component of antenatal care (Peabody, 1994). An estimated 92 percent of government health clients and 86 percent of hospital clients are assumed to actually obtain supplements either, free or purchased, and ingest them. An estimated 96 percent of private clients will obtain and consume supplements. Ninety percent of those to ingest the supplements are estimated to continue consuming them, assuming no change in side-effects.

3.3 EFFECTIVENESS ESTIMATES

The effectiveness indicator we use is the number of pregnant women in the latter half of pregnancy who take iron supplements. We define these as women who made at least one prenatal visit (in 1992) to government or private health care providers, were prescribed or recommended iron supplements by that service, purchased or were provided with supplements, and ingested the iron tablets. This includes women who received iron tablets from sources other than the government health service, and women who may have received less than the full course of tablets. Self-reported compliance and side-effects are used to estimate the number of women who continued taking the iron supplements.

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[6]Nutrition education is a key component of programs to improve compliance, in addition to actions such as assuring supplies and reducing participant costs (Galloway and McGuire 1994). The education should focus on client-provider interactions, reinforcing women's motivation to improve their health and well-being through improving iron status. The education should provide specific messages on dosage/frequency and duration. This nutrition education can also serve to improve the efficacy of iron supplements if easily understood messages on consuming iron without dietary inhibitors (tea, coffee) and with enhances of absorption (small amounts of meat and fish, vitamin C rich fruits and vegetables) were included.

The number of women who are estimated to have benefitted from the program, from the current and alternative programs are shown in Table 2. Of the 60,000 pregnant women in Jamaica, and 57,000 who attend at least one prenatal clinic, the 1992/93 program is estimated to have screened and prescribed supplements to approximately 38,000 or 64 percent. When compliance and continued use of supplements are taken into account, the program is estimated to be benefiting approximately 26,000 or 43 percent of all pregnant women. In the alternate scenario estimated, 85 percent of all pregnant women are being prescribed and counselled for iron supplementation and an estimated 70 percent are benefiting from continued use of the supplements.

3.4 COST ESTIMATES

3.4.1 Government Costs

Tables 3 and 4 give the cost estimates of the current and alternative programs. The total cost of the program is estimated at approximately $145,000 in 1992/1993, of which the major elements were supplements (39 percent) and screening (35 percent). The total cost of the revised program model is estimated at $63,000 - less than half of the original program. The main reductions are attributable to fewer hemoglobin tests and smaller number of supplements procured for free distribution through government antenatal clinics. Almost 60 percent of the cost of the revised program is attributable to staff salaries for antenatal counselling, with screening, supplements and public education taking up 20 percent or less.

3.3.2. Participant Costs

The costs of participation in the 1992/93 and alternative iron supplementation programs are in Table 5. Participant costs vary by type of service, which include government health centers government hospitals and private practitioners. Cost components include: travel and waiting time, transportation costs, laboratory and consultation fees, and supplements. Of those using government facilities, a significant number use private outlets for hemoglobin testing (32 percent of health center patients), and for obtaining supplements (81 percent of health center patients). Fifty percent of hospital patients are estimated to purchase their supplements.

Users of Government Health Services: The population of interest to us are all those women whose first antenatal visit is to a government health center or hospital. At that visit, 65 percent of health center clients and all hospital clients were sent for a hemoglobin test either to the public laboratory or private facilities, or the test was done on the spot. There was a small charge for tests at government facilities, and a higher fee for tests at private laboratories. They returned to the health center or hospital clinic with their results on a subsequent visit, and some were given iron tablets free of charge depending upon the results of the hemoglobin test, or sent to private pharmacies with a prescription. In 1992, clients sent to public laboratories were

required to pay US$0.90 for a hemoglobin test[7]. On their next visit to the health center, depending on the results of the hemoglobin test, the nurse dispensed iron tablets to them. The cost of transportation reported by women in exit interviews averaged US$0.23 per trip. The survey reported an average wait time of about three and a half hours for anaemia screening, which, using the national minimum wage (US$0.28/hour) comes to US$0.98 per visit. Estimated total 'participant's cost' for those pregnant women screened, prescribed and given supplements at the government facilities is estimated at US $ 2.11. About 35 percent of the sample reported being sent to private laboratories for hemoglobin testing, and the fee here was US$3.00 per test. The cost for women seen at government centers, given supplements at government centers but screened at private laboratories was US$ 4.21. Those using government laboratories but purchasing their own supplements are estimatd to spend US$ 7.11.

Users of Private Prenatal Clinics: Spot checking with health providers and Jackson's (1993) survey of government antenatal clinic attenders gave the following rough estimates of the costs a patient would incur who made use of private services: fee for hemoglobin testing US$3.00; cost of supplements US$10.00; transport US$2.00; lost time -average wait 1 hour at average pay of $2.00/hr -(US$2.00). The total cost for these women is estimated at US$ 17.00. Transportation and average hourly rate for private and public sector participants are different because of greater distances, different modes of transport used and different socio-economic profile.

The cost to participants is over three times greater when supplies are purchased rather than provided free of charge. Clients using private physicians are estimated to be paying over eight times more for iron supplementation; this is partly due to the higher opportunity cost of their time, more expensive transportation, and use of more expensive iron formulations.

3.4.3 Total Costs

Table 6 summarizes the government and participant costs of the current and alternative programs. The alternate program model reduces costs more for participants than government, even though more participants are now paying for their supplements. This is largely due to a reduction in hemoglobin screening costs. The total government and participant costs for screening are substantially reduced under the alternative program, while supplement costs increase due to a larger number of supplement users. There is also a shift from government to participants in the cost of procuring supplements under the modified program.

The total program costs are net of fees recovered from participants for screening.

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[7]Since this is an illustrative analysis, we assume US$0.90 to be the full cost of hemoglobin tests. However, we are unable to determine if in fact costs of all inputs (rent, equipment, materials, staff) and fee- servicing costs are covered. If US$0.90 for each hemoglobin test at a government laboratory, covers all the estimated costs for this activity, then the costs of screening should appear as participant costs alone.

3.5 UNIT COSTS AND COST-EFFECTIVENESS

The key cost-effectiveness issue addressed here, and for which the indicators have been developed, is whether modifications can make the existing program be more efficient (lower government costs per woman benefitted). An important corollary is that to increase coverage and sustainability, a reduction in participant costs is important. The following parameters are used to compare the 1992/93 program with the alternative program:

(i) government costs per antenatal case;
(ii) total annual government costs as a percent of health budget;
(iii) combined government plus participant costs per antenatal case;
(iv) participant costs of government clients as a percent of minimum wages.
(v) government plus participant costs per person benefitted.

Table 7 summarizes the cost and cost-effectiveness indicators calculated for the current and alternative programs. Iron supplementation for pregnant women is a low cost program in relation to the national health budget. Given that anemia is among the top ten contributors to the national disease burden among women, the investment of .02 to .03 percent of the national health budget is clearly justified. Iron supplements are among the lowest cost supplies, equalling less than .03 percent of the drugs budget at most.

The current program as implemented in 1992/93 is not as efficient as the revised model, and the potential gains in cost-effectiveness are considerable. An estimated two-thirds of the cost to government can be reduced. The key policy changes needed are: elimination of universal screening and free supplies procured to meet the needs of only approximately 20 percent of all clients seen at government health clinics. Low cost but critical additional elements of the revised program include greater investments in public education and monitoring the counselling and supply activities.

Participant costs appear to be high in relation to minimum wages. However, many of those at minimum wage or lower economic levels are expected to be given free supplies. It is possible that transportation costs and opportunity costs of waiting times have been somewhat overestimated. For example, each visit may be used for multiple purposes, and not only for participation in the iron supplementation program. Nevertheless, the process of estimating costs to participants highlights the importance of tracking this element if sustained participation and compliance with protocols are desired. There may be an opportunity to further reduce costs through marketing a low cost package of iron supplements.

3.6 DISCUSSION

Before discussing the conclusions and policy implications from such an analysis, some caveats should be taken into consideration. Firstly, this analysis did not use firm, quamtitative estimates of impact on cases of iron deficiency averted. There is also a lack of confidence in estimates

of coverage, dosage and compliance. Secondly, the information used for developing estimates is largely qualitative at the level of users of antenatal health care services, since women were not randomly selected. Its broader applicability has not been verified. Nevertheless, some major issues such as supplies of iron supplements at health centers and non-functional screening system were identified. This suggests that expensive clinical or household surveys may not be warranted when an initial, broad review of program implementation and efficiency issues is desired. This analysis was adequate for highlighting the economic implications of implementation problems. Exit interviews with women and service providers at health centers were a useful indication of coverage. This helped identify some major bottlenecks in achieving greater efficiency in the program. The importance of this type of information for decision-makers was seen in the action taken by the MOH to improve supplies at health centers and restructure the screening system. The analysis also highlighted the gap in the national iron deficiency control strategy with reference to infants. This should receive top priority given the high prevalence of iron deficiency in this age group (see Table 1).[8] However, such a program has not been broadly implemented and data on costs, coverage and quality were unavailable.

One conclusion from this experience is that expensive and time consuming primary data collection efforts may not always be warranted when a program of this type has not been reviewed using existing data first. It is possible that significant improvements in program implementation can result initially from a careful review of the conceptual framework of the program strategy, using largely secondary data. A systematic review of each stage or activity of the program in terms of how it contributes to effectiveness and costs was valuable in prioritizing recommendations for action.

3.6.1 Factors Affecting Effectiveness

The results confirm that low coverage is a major problem in iron supplementation programs. In the Jamaica program an estimated 50 percent of the loss in effective coverage (proportion of pregnant women in the second half of pregnancy taking iron supplements) can be attributed to non-procurement of supplements by women either due to lack of supplies at health centers, or lack of counselling provided to ensure purchase of the supplements. In contrast we estimate tht only an additional five percent of the loss in effective coverage can be attributed to women not taking the supplements because of self-reported side-effects. The health centers play a critical role in the program because a high proportion of pregnant women at risk of anemia are seen here during the second half of pregnancy. They are already playing an important role in motivating pregnant women. According to our survey, a large proportion (about 90percent) of

[8]Immunization coverage is a good indication of the potential coverage from using the existing MCH services through health centers (current coverage is estimated at 82% for three DPT shots, 63% for measles, World Bank, 1994). The additional costs of reaching a high proportion of infants because of additional training, supply systems and education/counselling may be marginal, as a similar system to the one proposed in the alternative program for pregnant women would be appropriate for a supplementation program for children. It is hoped that technical guidelines on pediatric formulations and dosages are being developed (OMNI/UNICEF/WHO) and will help move these actions forward.

women who knew about iron reported receiving information from the health center, of which 60percent heard about it from multiple sources.

The pharmaceutical industry has a retail supply system that appears to function well enough to be a potential supplier for a large segment of women needing supplements. However, some arrangement needs to be made for those at or below minimum wages. The costs of purchasing supplements is estimated at 1 percent of minimum wages. In general, there appears to be a high level of awareness of the benefits of iron supplements, and this advantage can be capitalized upon through increasing the supply of lower-cost iron supplement packs available through pharmacies. Health centers need to continue and increase their counselling and education activities at each contact with women seen not only during pregnancy but also at well-baby clinics. Replenishment of iron stores during inter-pregnancy intervals can be achieved if women continue to take supplements after delivery.

3.6.2 Factors Affecting Costs

Treatment of severe cases: Estimated at 6 percent of all pregnant women will need replacement therapy (Simmons 1994), and costs need to be covered by government, assuming mostly these are indigent women, and unable to pay. The cost of this program component will influence the total costs of the program, but probably not the conclusions of the analysis.

Screening for hemoglobin: Clearly, sharply reducing this activity has important repercussions. Replacement of the universal screening requirement of the 1992/93 program with the use of hemocue method of screening (current policy) will clearly not achieve the savings possible.

The cost of reagents and supplies for hemoglobin analysis are a large cost (32 percent) to the government and perhaps underscores the point that in the Jamaican economy any program component that is solely dependent on foreign inputs will absorb a disproportionately large amount of program cost because of the value of the Jamaican dollar relative to its United States of America counterpart. Personnel cost are relatively low, well below the percentage expected for programs of this nature, but reflect the fact that public sector wages (already low by international standards) are not very significant when converted to US dollars. Supplements accounted for the single largest component of costs (37 percent). Personnel costs may be slightly underestimated as costs for doctors services (when required) are not included.

3.6.3 Recommendations

The main recommendations from this study are as follows:

1. Encourage clients to purchase iron supplements from pharmacies.

2. Replace universal screening for hemoglobin using the 1992/93 method. If a low-cost screening method (such as Hemocue) is found to be practical for large scale field implementation, develop a system for monitoring and quality control to ensure functioning equipment, supply availability, adequate handling of biological materials (blood), and reporting of results in a way that contributes to program impact and efficiency. For Jamaica, given the high prevalence of iron deficiency anemia among pregnant women, it may be cost-effective to provide supplements to all women.

3. Conduct exit interviews with antenatals to conduct coverage and quality assessments of the program. Establish better system of cost accounting for periodic cost-effectiveness tracking.

4. Expand public education to create and maintain high demand for iron supplements and inform the public about the need for improving iron status from consuming supplements and modifications in food habits.

5. Given the gap in reaching young children - a high risk group for iron deficiency - the cost-effectiveness and feasibility of supplementing infants and young children under 24 months should be estimated, and an efficient program implemented.

6. Improve iron supplement supplies at government health centers.

4. FORTIFICATION

The fortification of foods is a well-established intervention for reducing micronutrient deficiencies globally (Nestel 1994). In much of the industrialized world fortification is credited with having practically eliminated deficiency diseases such as goiter, beri-beri and anemia. The success of fortification is based on the technology of adding small amounts of minerals and vitamins to processed foods without changing their appearance, taste or acceptability of the food product, and selecting foods commonly eaten by the intended target groups, thereby avoiding the need to change food habits.

For developing countries, the full potential from food fortification is yet to be realized, partly because those who need the nutrients most do not purchase centrally processed and packaged foods. For some nutrients, environmental conditions and technology limitations are constraints. The lack of a system for mandating and enforcing food standards, is also an issue. Nevertheless, a large segment of the population that could potentially benefit significantly from fortified foods is not doing so from lack of focused national strategies and actions.

In this section we examine the costs and projected coverage of wheat fortification activities in Jamaica in relation to the prevalence of iron deficiency. The main policy issues are whether the chosen vehicle(s) or food(s) in fact reach those segments of the population at risk of deficiency and whether the choice of fortificant is the most appropriate.

4.1 METHODOLOGY

Information on the functioning of the iron fortification program in 1992 was obtained from the Jamaica Flour Mills. Interviews with key personnel (quality control manager and stockman) at Jamaica Flour Mills, and annual reports were the main sources of information. Data on of the amounts of wheat flour milled, the process of fortification, fortificant levels and costs were obtained. This was supplemented with visits and observations at the processing plant.
Faculty of the business school of the University of West Indies (UWI) conducted the cost analysis. A dissertation on the use of wheat and cornmeal as potential vehicles for fortification forms the basis for several elements of the effectiveness analysis (Jackson 1991). In this study, a cross-sectional survey of 240 households with pre-school age children was conducted in Kingston and St. Andrew to determine the frequency of wheat and cornmeal consumption by households, and quantitative estimates of intakes by women nd children using 24-hour recall. Information on dietary intakes of iron was obtained from a national household survey. In collaboration with the Planning Institute of Jamaica, the Statistical Institute of Jamaica carried out the Jamaica Survey of Living Conditions in 1991. Data from this survey on food expenditures is used to develop estimates of the households with access to adequate dietary iron, with and without fortification.

Effectiveness Indicators

We measure effectiveness as the additional number of individuals who consume sufficient iron as a result of iron fortification of wheat flour. The approach was to identify the number who have inadequate dietary iron when flour is not fortified, and then to estimate how many of these are consuming fortified flour in sufficient quantities to receive adequate iron nutrition.

The Jamaica Survey of Living Conditions (SLC) conducted in November 1991 provided information on household food expenditure, from which it was possible to determine the amount of iron consumed in the diet firstly assuming that the flour was fortified and then that it was not. In the survey, data were collected from a sample of 1,786 households, representative of the Jamaican population, and selected using a two-stage stratified sampling technique.

The data obtained from the questionnaires was in monetary terms and was converted to iron intake levels as follows: (i) per capita expenditure on each food item (including the value of gifts and home production) was obtained by dividing total expenditure by household size (ii) the price per kilo of each item was used to derive from (i) the quantity of each item purchased and (iii) the iron content per kilo of each item was determined using food composition tables and (iv) iron intake was calculated as the product of (ii) and (iii).

Total expenditure on all items was used as a proxy for income and social class: the first quintile comprising the poorest 20 percent and the fifth quintile representing the richest 20 percent of the sample.

The daily per capita consumption of iron estimated from these analyses were compared with 1988 median "basal intake" levels recommended by FAO/WHO (1988). This is the amount of dietary iron required to maintain a normal supply of iron to tissues and preserve all clinically detectable functions. The assumed bio-availability of the diet is 10 percent based on FAO/WHO criteria that these diets consist mainly of cereals and negligible quantities of foods of animal origin or ascorbic acid (vitamin C), both of which promote iron availability. Since iron needs vary by sex and age, household composition of each expenditure quintile and rural/urban group was taken into account when estimating needs. Those households who achieved 75 percent of the recommended intakes were counted in the effectiveness denominator. This is because partial fulfillment of iron needs constitutes a benefit for nutritional status (unlike immunizations or drugs that have a threshold below which they are ineffective). There is also a safety factor built into the FAO/WHO recommendations and households reaching 75 percent of recommended levels are probably consuming adequate amounts.

4.2 PROGRAM DESCRIPTION

Wheat, corn and rice are the main staples of the Jamaican diet. Wheat flour is consumed by over 95 percent of the households from all socio-economic segments of the population. Forms in which wheat flour is consumed include dumplings (made from counter flour) and to a lesser extent, bread (mainly in the higher socio-economic groups). It has been the principal vehicle for

iron fortification in Jamaica. Other processed foods with added iron, such as infant cereals and formula are also available, however they reach a very small fraction of the national population.

All wheat consumed in Jamaica is imported. Historically, a significant proportion of wheat as flour was imported into Jamaica. Later, when wheat was imported as grain, the flour mill where wheat grain was milled locally, was owned by a U.S. company. Because of these reasons, wheat flour contained iron at the level required by U.S. law. From 1955, by notice under the Trade Law, iron fortification of imported flour (both, baking flour sold to bakeries and counter flour sold at retail for home consumption) was required at the level of 28-36 mg/kg (Simmons 1980). Baking flour accounts for about 40 percent of all wheat consumed in Jamaica, and counter flour for 60 percent. Since July 1984 all baking and counter flour has been milled in the country, at a central processing plant of the Jamaica Flour Mills. Both types of flour contain B vitamins[9], and iron at 44 mg/kg.

The milling plant where fortification occurs, is located on the shore. Vessels bringing wheat offload whole grain wheat directly at the storage sites of the milling plant. The wheat then undergoes standard cleaning and milling procedures, with additions of stabilizers, fortificants, and other additives occurring at the end of the processing, after sifting, and just prior to packaging. The plant operates two to three shifts per day depending upon material availability and demand.

The quality control manager is responsible for fortification activities at the flour mill. The iron fortificant is purchased in the form of a pre-mix that contains other nutrients (B vitamins) and additives. The form of iron used is hydrogen-reduced iron with a relatively large particle size. It is added mechanically by a pre-calibrated "enrichment feeder" that automatically drops a specified amount of the pre-mix at specified intervals into the flour. The feeders are checked and refilled from time to time by two "rollermen" who also check other equipment. The rollermen have one supervisor. Two general workers are responsible for cleaning. The enrichment feeders are imported from the U.S., from the same company that supplies the enrichment pre-mix, and the company representative checks and repairs the feeders as part of the service contract included in the price of the feeders. Jamaica Flour Mills does not analyze iron levels as part of quality control.

4.2.1 Current Status

From July 1991 to June 1992, the Jamaica Flour mills reported producing 3,221,086 bags of 45 kg each for a total of 144,950,000 kg. This provides approximately 144,950,000 kg * 2.2 lb/kg a total of 318,890,000 lbs of flour, or 133 lbs per person per year (total population of 2.4 million). This provides approximately 0.36 lbs per day or 164 grams of wheat flour per person daily at the aggregate level, without accounting for wastage and losses.

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[9]Thiamine at 6.3 mg/kg, riboflavin at 3.9 mg/kg, and niacin at 52.8 mg/kg.

Data related to food consumption practices (Jackson 1991) and research on the efficacy of iron fortificants (Hurrell, 1990 and 1985) raise two main issues for the current wheat fortification program in Jamaica:

- Firstly, while there are indications that rural low income households consume wheat flour products, certain age groups in particular infants and young children, especially the 6 to 24 month age group, may not. A household survey of low income areas found that 95 percent of both, rural and urban households reported consuming wheat flour the previous week, and intakes averaged a pound per person per week. However, children in the under 2 category consumed on average very small amounts. Cornmeal, was less widely consumed overall (88 percent rural and 83 percent urban), but was relatively more commonly eaten in rural families, and was frequently given to children under 2 years as weaning food in the form of porridge with milk. Children in this age group, are among the most highly vulnerable to iron deficiency. Cornmeal is not fortified with iron.

- Secondly, recent research on the efficacy of iron compounds available for food fortification shows that the form of iron used in Jamaica is not as well absorbed as other fortificants. Iron compounds that can be added to cereals include ferrous sulphate, ferrous fumarate, hydrogen reduced elemental iron (large particle size), electrolytic elemental iron (small particle size), ferric pyrophosphate, ferric orthophosphate and iron EDTA (ethylene diamine tetra-acetate). These compounds vary in their absorbability; cost; and impact on color, flavor and rancidity or shelf life of the food product fortified. Hydrogen-reduced elemental iron, that is currently used in Jamaica, has a large particle size and is less absorbable than other forms, but has a longer shelf-life and costs less. Experience in other countries and clinical trials suggest that ferrous sulphate or iron-EDTA would be better absorbed and thus more effective in improving iron status.

4.2.2 Program Modifications

Ferrous sulphate and iron EDTA are the fortificants used in the modified program scenario analyzed in our study. The analysis is based on estimating the amounts of these fortificants needed to deliver the same level of iron to tissues as reduced iron. Thus, effectiveness estimates remain constant, assuming an equal number of individuals will benefit from the program. Costs are based on the different amounts and prices of fortificants needed to provide an equivalent amount of absorbed iron. A program model that would inlcude cornmeal fortification was not assessed due to insufficient information.

4.3 EFFECTIVENESS ESTIMATES

Table 8 provides a summary of effectiveness results. Variables that were taken into consideration to develop these estimates are discussed below:

Iron intake without fortification: Calculations based on the national household expenditure survey (SLC) suggest that without fortification, 27 percent of all households are getting 75

percent or more of their iron requirement. Of the 73 percent of households who do not have access, 133,000 are located in rural areas and 154,000 in urban areas (based on World Development Report 1994 estimates of 54percent urban). All members of the household (all ages and both sexes) are considered beneficiaries of the improved iron intake, given the broad-ranging deficits in diets, and detrimental effects of inadequate iron.

Level of iron fortification in wheat: The Jamaica Flour Mills has, since 1984, aimed at a fortification level of 44 mg/kg, and actual levels of fortification from a survey of wheat flour samples obtained by us from 20 retail sites in the country showed that they average 39.88 $\pm$ 7.06 mg/kg. No differences were found in urban and rural samples.

Dietary consumption of iron with wheat fortification: With fortification, 50 percent of the households - or 1,200,000 persons (total population 2.4 million), are estimated to be getting 75 percent or more of their iron requirement. This translates into 42,000 rural and 46,000 urban households.

Impact of wheat fortification on iron intake: The program of fortifying flour with iron is estimated to have almost doubled the number of persons accessing at least 75percent recommended iron. This translates into an additional 530,000 persons living in households who purchase sufficient food to cover iron needs.

4.4 COSTS

Detailed quantitative information on costs was not available. However, qualitative information on a number of cost components was obtained. Information on manufacturer costs were obtained from the Jamaica Flour Mills 1992 annual report of expenditures and income (for the period June 1991-July 1992), interviews with the supervisor and quality control manager, and direct observation. Staff time spent in the factory on the enrichment of flour was estimated by the supervisor, quality control and stocks maintenance staff. Salaries and benefits were obtained from Jamaica Flour Mills for each member of staff identified. It was estimated that over 95 percent of the cost of fortification was for the premix containing iron. Since 1984, the Jamaica Flour Mills has had a contractual arrangement in which they pay a flat fee to their supplier of premixes - ELF ATOCHEM North America - a U.S. firm based in Buffalo, New York. For this fee the suppliers supply the nutrient mixes, lease and maintain the feeders and provide technical advice. No in-house iron analysis is done but samples of wheat flour are sent semi-annually to the Jamaica Bureau of Standards for testing of other components. Because the testing has no relevance for the iron fortification, it is not included in the costs. Building costs are negligible, as they were incurred for the flour milling operation not for fortification. We focus the analysis on the pre-mix costs. It is estimated that in 1992 Jamaica Flour Mills had an annual production of 144,950,000 kilograms of flour.

Current prices estimated by one of the suppliers of pre-mixes for varying iron sources are shown in Table 9.

4.5 COST-EFFECTIVENESS

Table 10 provides a summary of the cost-effectiveness results. The cost per person benefitted ranged from $0.12 to $0.34. Of the fortificants compared, Iron EDTA combined with Ferrous Sulphate and Ferrous Sulphate alone are the most cost-effective options, although all iron sources were in a similar range of cost-effectiveness. Varying bio-availabilities reduced the disparities in prices of the fortificants.

The approach and methods used in this analysis have a number of implications for interpreting the results. These are summarized below, before proceeding with the discussion.

- Ideally, the measure of effectiveness should be more closely related to desired benefits of the program, and in this case a reduction in the biochemical indices of iron deficiency would have been preferable. However, as noted in section 2 (Introduction), a valid estimation of changes in these indicators, attributable to the program would require resources beyond the scope of most programs. In this case, such an investment is not justified, also because even the preliminary estimation of effectiveness shows serious deficiencies in the program which can be corrected with relatively modest investments.

- The calculation of the number of beneficiaries does not take into consideration the lack of access to iron in wheat flour products by children under the age of two years. This is problematic not only because it results in a slight underestimation of cost per person benefitted, but because this relatively small segment of the population accounts for a substantial proportion of those in greatest need, it has important repercussions for policies to improve the program.

- Estimates of per capita iron accessibility did not include meals taken away from home, home-produced foods and food received as gifts. In addition the survey did not cover all seasons and there is a likely underestimation of consumption. The analysis may therefore overestimate the size of the iron deficient population. Without further information, it is not possible to determine if this is likely to change the effectiveness estimates.

- A single measure of the relative bioavailability of an iron source should be used with caution, as it is only an approximation of actual absorption (Hurrell, 1985). An average level of absorption has been used, although some variation in certain segments of population is likely. Other ingredients in the food consumed affect the relative acidity of the gastrointestinal tract during absorption and the presence of inhibitors or enhancers influence bioavailability as well. This particularly affects hydrogen-reduced iron. Iron-EDTA is considered to be especially resistant to the influence of food ingredients. The iron status of the person consuming iron also determines absorption, with higher absorption in a deficient individual. Again, without more detailed information, it is not possible to determine the extent to which different economic strata and age groups have different bioavailabilities.

The above qualifications suggest that this analysis should be considered exploratory and only large differences in cost-effectiveness should be taken into consideration for program and policy determination. The analysis does clearly point to some areas of improvement.

At present levels of fortification (44mg hydrogen-reduced iron/kg wheat flour), a substantial number of households do not have access to levels considered adequate. In the case of Jamaica, our analysis suggests that at an average per capita production of 164 grams/day of wheat flour, and building in a 20 percent wastage factor, and at 40 mg iron per kg, intakes of iron increase by 5.2 mg per capita per day. This is in a similar range as the analysis by Simeon suggesting that average intakes improved from 8.4 mg/person/day to 12.3 mg, or an average increase of approximately 4 mg. This 12.3 mg of iron is slightly below the national per capita requirements estimated at 12.8 mg. However a number of distributional problems are masked by these aggregate calculations. When Simeon's calculation are done on expenditure quintiles and rural/urban distributions, the disparities among households become more readily visible. As noted above, the prevalence of low iron diets may be somewhat overestimated, however, it is likely that given the magnitude of disparities, the lowest expenditure quintiles, and rural households are unable to buy enough food to meet their dietary requirements for iron even after taking into account additional iron from fortification.

4.6 DISCUSSION

Our results suggest the need for providing additional iron. One option is to simply increase the amount of iron per kg of wheat flour. This has the advantage of not requiring any change in processing. However, higher iron levels may alter the acceptability and shelf life of wheat flour, especially if fortificants other than reduced iron are used. Most importantly, the youngest age group is not consuming wheat flour products and despite household adequacy at the household level, children in the 0-2 year age group will continue to receive a severely deficient diet. This gap might be filled with a supplement distribution program for this age group, conducted through the MCH program (along with immunizations for example, which has high national coverage at least for children until one year of age), using health centers as the primary delivery system. Another option is to fortify cornmeal, the staple used in weaning age children's diets, as well as consumed by over 80 percent of the general population. The technology for fortifying cornmeal is identical to that of wheat flour; however, the fortificant may be different given differences in rancidity due to higher fat content. The advantage here would be a low-cost delivery system that reaches children throughout their preschool years. The costs and effectiveness of these alternatives need to be examined more carefully.

5. CONCLUSIONS AND RECOMMENDATIONS

The framework developed in this report has been useful, primarily because the financial implications of implementation problems were highlighted. Exit interviews with women, though not indicative of impact without biochemical indicators, provided important guidance in developing coverage estimates. This helped highlight key bottlenecks in achieving high coverage. The importance of this type of information for decision-makers was seen in the action taken by the MOH to improve iron supplement supplies at health centers.

The main policy recommendations for the supplementation program are to encourage clients to purchase iron supplements from pharmacies, and to reconsider universal screening for hemoglobin, the elimination of which can reduce government and participant costs substantially. If a low-cost screening method is found to be practical for large scale field implementation, a system for monitoring and quality control will need to be designed to facilitate and track achievement of program impact and efficiency.

The program of fortifying flour with iron is estimated to have almost doubled the number of persons accessing at least 75percent recommended iron. This translates into an additional 530,000 persons living in households who purchase sufficient food to cover iron needs. However the current system is not conducive to consumption of adequate iron, both in the levels consumed by those who are participants in these programs, as well as groups not being reached at all, in particular, young children.

Our results suggest the need for providing additional iron. Higher iron levels may alter the acceptability and shelf life of wheat flour, especially if fortificants other than reduced iron are used.

The youngest age group is not consuming wheat flour products and despite adequacy at the household level, children in the 0-2 year age group will continue to receive a severely deficient diet. This gap might be filled with a supplement distribution program for this age group, conducted through the MCH program.

Of the fortificants compared, Iron EDTA combined with Ferrous Sulphate and Ferrous Sulphate alone are the most cost-effective options, although all iron sources were in a similar range of cost-effectiveness. Varying bio-availabilities reduced the disparities in prices of the fortificants. However, controlled trials of acceptability and efficacy under field conditions need to be consucted, before policy changes can be recommended with confidence.

The study raises strategic issues such as the lack of interventions directed to benefit infants and young children, the need for a mix of interventions that would include fortification of other food consumed by weaning age infants, and supplementation not only for women but for infants and young children as well. While dietary deficiencies appear to be the primary cause of iron deficiency in Jamaica, in other countries, malaria and intestinal parasites may be important etiological factors, and comprehensive intervention packages to combat iron deficiency will need

to address these components as well.

A comparison of the costs of the two programs shows that the cost per person benefitted ranged from $0.12 to $0.34 for fortification and $9.24 for supplementation. It can be argued that infants born to mothers in the supplementation program also benefit from prenatal iron, and the cost per beneficiary is therefore lower ($4.62). The supplementation program is still over ten-fold more costly than fortification. This is typical of fortification versus supplementation comparisons. Food fortification is far less costly because the delivery system, generally reaching a larger population, does not require the expense of personnel-intensive counselling and distribution that supplements require. The technology of fortification as well as the fortificant are very inexpensive relative to the large number of persons who are reached. Food staples such as cereal flour, sugar and salt have an unparalleled coverage, especially relative to regular health services use by high risk populations on which supplements are dependent.

Nevertheless, iron supplementation is an essential component of all iron deficiency control strategies, even if successful efficacy trials lead to the selection of iron fortification as the main intervention. This is because, requirements for iron during pregnancy are significantly higher than iron requirements at any other stage; and if adequate iron were provided through fortified foods, they would potentially carry a risk of toxicity for young children in particular. Acceptability and shelf-life would also be constraints.

What is the evidence that iron deficiency can be controlled through a combination of supplementation and fortification? Only a limited number of studies have been done to determine the effectiveness of iron fortification toward improving iron intakes and iron status. Three studies involved the addition of iron sources to flour and bread (Hallberg et al 1979, Cook et al 1973, Bazzano and Carter, 1978). Hallberg et al (1979) estimate that approximately 40 percent of the improvement in iron status of Swedish women is attributable to iron fortification. The prevalence of iron deficiency has declined from 25-30 percent when iron fortification wa first started to the present level of about seven percent. The daily amount of added iron is 8 mg, and this added to 11 mg in the native diet provides a total intake of 19 mg. Reduced carbonyl iron is the iron source. Use of iron and ascorbic acid supplements were also an important factor in the observed reduction of iron deficiency.

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Table 1: PREVALENCE OF IRON DEFICIENCY AND ANEMIA IN JAMAICA

Indicators	Population Groups					
	Pregnant women	**Lactating women**	**< 24 months**	**24-47 months**	**5-14 years**	**15-19 years**
Hemoglobin (% below WHO standard)	52	42	73	38	20	31
Dietary iron intakes (% below FAO/WHO recommended levels	84	85	63	50	43	61

ource: IDRC, UWI, MOH/Jamaica. 1987. Report on Iron Nutritional Status and Nutritional Anemia in ımaica.

Table 2. Effectiveness Estimates: Number of Women Benefiting

	Current Program		Alternative Program		Benefitted no. (% of target)	
	%	No.	%	No.	Current	Alt.
Total number of pregnant women **eligible**	100	60,000	NC	NC	Target = 60,000	
% Attended prenatal clinics	95	57,000	NC	NC		
of which:						
Government clients,	85	48,400				
of which:						
-Health center users	82	39,500				
-Hospital users	18	8,900				
Private clients	15	8,600				
% Screened (of those who attended clinics)						
Government clients						
-Health center users,	65	37,050	10	3,900		
of which						
-at govt. labs.	68	25,194	68	2,652		
-at pvt. labs.	32	11,856	32	1,248		
-Hospital users (govt.)	100	8,900	10	890		
Private clients	100	8,600	100	8600		
% Prescribed Supplements (of those who attended)					38,235 (63.7)	51,270 (85.4)
Government clients,						
of which:						
-Health center users,	57	22,515	90	35,550		
of which:						
-free from govt.	19	4,278	20	7,110		
-purchased	81	18,237	80	28,440		
-Hospital users,	80	7,120	80	7,120		
of which						
-free from govt.	50	3,560	50	3,560		
-purchased	50	3,560	50	3,560		
Private clients	100	8,600	100	8,600		

NC = No change

Table 2. (contd.) Effectiveness Estimates: Number of Women Benefiting

	Current Program		Alternative Program		Benefitted no. (% of target)	
	%	No.	%	No.	Current	Alt.
Procurement and use (of those prescribed)					28,883 (48.1)	47,013 (78.4)
Government clients						
-Health center users	66	14,860	92	32,634		
-Hospital users	81	5,767	86	6,123		
Private clients	96	8,256	96	8,256		
Compliance (those who procured supplements and used them, % who did not report side effects)					25,994 (43.3)	42,311 (70.5)
Government clients	90	18,564	90	34,881		
Private clients	90	7,430	90	7,430		

Table 3. Costs of the 1992/93 Program Model

Activities and Inputs	Personnel[1]	Supplies	Equipment and Vehicles	Space	Education Materials[2]	Total
Antenatal counselling	35,487	0	0	0	0	35,487
Training	0	0	0	0	0	0
Subtotal	35,487	0	0	0	0	35,487 (24.8%)
Screening	2,500[3]	46,205[4]	676[5]	0	0	49,381 (34.6%)
Supplements	500	52,887[6]	2,252	135	0	55,774
Monitoring	0	0	0	0	0	0
Subtotal	500	52,887	2,252	135	0	55,774 (39.0%)
Advertising/ education	0	0	0	0	2,252	2,252 (1.6%)
TOTAL	38,487 (26.9%)	99,092 (69.3%)	2,928 (2.0%)	135 (<.1%)	2,252 (1.6%)	142,894 (100%)

NOTES:

1. The estimated percent of total work year dedicated to the task, times the number of staff involved, time: the midpoint of the salary scale for that particular staff category.
2. Education materials include tapes made for radio broadcasts, posters in the waiting area and flip-charts.
3. Based on the survey result (64.9% of 39513), estimating the time that would be required to analyze the: samples in the public sector, then multiplying this time by the average annual public sector laborato technician's salary.
4. Hemoglobin screening costs covered only drugs and supplies and was based on private sector cost f supplies utilized in the analysis of one hemoglobin multiplied by the estimated number of hemoglobin analys done in the public sector for the period being considered.
5. Vehicle maintenance costs were based on estimates of key public sector medical and administrative perso nel. Maintenance of equipment for screening is also included; figures were based on estimates of key publ sector medical and administrative personnel.
6. 1990 base line data was used to get an average price per dose of iron supplement. This unit price was th adjusted to 1992 equivalent by using figures for the year on year inflation in drug and health care as publish by the Statistical Institute of Jamaica.

Table 4. Costs of the Alternative Program Model

Activities and Inputs	Personnel	Supplies[1]	Equipment and Vehicles	Space	Other	Total
Antenatal counselling						
Staff salaries and benefits	35,487	0	0	0	0	35,487
Training	1,500	0	0	0	0	1,500
Subtotal	36,987	0	0	0	0	36,987 (58.6%)
Screening[2]	263	7,027	676	0	0	7,966 (12.6%)
Supplements	500	8,780	2,252	135	0	11,667
Monitoring	1,000	0	0	0	0	1,000
Subtotal	500	8,780	2,252	135	0	12,667 (20.1%)
Advertising/ education	0	0	0	0	5,500	5,500 (8.7%)
TOTAL	38,750 (61.4%)	15,807 (25.0%)	2,928 (4.6%)	135 (.2%)	5,500 (8.7%)	63,120 (100%)

OTES:

Based on 3560 hospital users and 7110 health center users given free government supplies. Of these, 25% e expected to require therapeutic doses of one tablet daily throughout pregnancy, and the others one tablet ily for 6 weeks.

Screening costs prorated for lower number screened at government facilities.

Table 5. Participant Costs of Iron Supplementation (US $ per participant in the 1992/93 program)

	Govt. labs, supplies	Govt. labs, pvt. supplies	Pvt. labs, pvt. supplies
Counselling and education	0	0	1.00
Screening			
Laboratory analysis fee	0.90	0.90	3.00
Waiting time	0.98	0.98	2.00
Travel	0.23	0.23	2.00
Supplements			
Supplements	0	5.00	10.00
Total cost per woman	2.11	7.11	17.00

NOTE: Government clients do not pay fees for antenatal visits. For clients of private doctors, 10 percent of consultation fees or US $ 1.00 has been attributed to iron deficiency control. Differences in opportunity cost of clients time, different modes of transport, and choice of lower priced supplements by government clients accounts for the differences in cost elements.

Table 6. Total Costs of Iron Supplementation

Activities	1992/93 Program		Alternative Program	
	Government costs	Private costs	Government costs	Private costs
Consultations	35,487	8,600	36,987	8,600
Screening	49,381	215,130	7,966	76,410
Supplements	55,774	194,985	12,667	246,000
Other	2,252	0	5,500	0
(Costs recovered from lab. fees)	(30,685)	0	(3,188)	0
TOTAL (net costs)	112,209	418,715	59,932	331,010
Combined total costs	530,924		390,942	

Table 7. Unit Costs and Cost-Effectiveness of Iron Supplementation

Indicators	1992/93 Program	Alternative Program	Difference %
Annual costs of the program (govt.)	$112,209	$59,932	- 47%
Annual costs as % of health budget[1]	.030%	.016%	
Annual costs of supplements as % of budget for drugs[2]	.028%	<.005%	
No. women reached through antenatal clinics/yr.	57,000	57,000	
Cost per antenatal patient seen/yr. -Govt. -Participant	 $1.97 $7.35	 $1.05 $5.81	 - 47% - 21%
No. women benefitted/yr.	25,994	42,311	+ 63%
Cost per woman benefitted/yr. -Govt. -Participant	 $4.32 $16.11	 $1.42 $7.82	 - 67% - 51%
Participant costs as a % of minimum wages[3](govt. clients)	2.75%	1.35%	- 51%
% of all pregnant women benefitted	43.3%	70.5%	+ 63%

1. Health budget J$380 million for 1991-92 (World bank, 1994)

2. National budget for drugs = J$190 million (World Bank, 1994)

3. Minimum wage J$250/week or J$ 13,000/year (@52 weeks/yr).

Table 8. Estimated Effectiveness of Iron Fortification of Wheat Flour

	Rural	Urban	Total
Total Population (1992)[1] Household (HH) Size[2] Number of HH[3] **Iron Intake Without Fortification:**	**1.1m** **6.2** **175,000**	**1.3m** **5.9** **220,000**	**2.4m** **6.1** **395,000**
% HH consuming < 75% of recommended[4]	76	70	73
No. HH consuming < 75% of recommended	133,000	154,000	287,000
Level of Iron in Fortified Wheat Flour[5]	40 mg	40 mg	40 mg
Iron Intake With Fortification:			
% HH consuming < 75% of recommended[6]	52	49	50
No. HH consuming < 75% of recommended	91,000	108,000	197,000
Reduction in No. HH Consuming < 75% of Recommended[7]	42,000	46,000	88,000
Reduction in Population Consuming < 75% of Recommended	260,000	270,000	530,000

. 1994 World Development Report, World Bank.
. M. Jackson 1991. Dissertation on Iron Fortification.
. Rounded off to nearest the 5,000.
. D. Simeon, 1993.
. D. Ramdath, 1992. Analysis of wheat flour samples (Blackwood-Harriott, 1993), found 40 mg. per kg.
. D. Simeon, 1993.
. No. HH consuming < 75% with iron fortification - no. HH consuming < 75% without iron ortification.

Table 9. Iron Firtfication Cost Estimates by Iron Source

Source	Cost of delivered iron in $/kg Fe	Cost to add 44 mg Fe per MT flour	Cost to add 38 mg Fe per MT flour	Total Fe cost/ 144,950 MT @ 44 mg	Total Fe cost/ 144,950 MT @ 38 mg	Cost for vitamins	Total cost $ per MT flour @ 44 mg	Total cost $ per MT flour @ 38 mg	Bio-availability	Total cost adjusted for bio-availability, @ 44 mg	Total cost adjusted for bio-availability, @ 38 mg
Current (reduced iron)	1.80	0.09	0.08	13,045	11,600	1.17	1.26	1.25	0.3-0.5	1.26	1.25
Ferrous Sulphate	6.50	0.29	0.25	42,035	36,240	1.50	1.79	1.75	1.0	0.54-0.90	0.53-0.88
Ferrous Fumarate	17.30	0.78	0.67	113,061	97,100	1.50	2.28	2.17	1.0	0.68-1.14	0.65-1.09
Iron EDTA	114.00	5.01	4.33	726,200	627,000	1.50	6.51	5.83	4.0	0.49-0.81	0.44-0.73
Ferrous Sulphate + EDTA	76.00	3.35	2.89	485,582	418,900	1.50	4.85	4.39	4.0	0.36-0.61	0.33-0.55

Table 10. Cost-Effectiveness of Iron Fortification of Wheat Flour

	Total No. Persons benefitted	Total Cost US $ (1992) @ 38 mg Fe per kg	Cost per Person Benefitted
Current program (reduced iron)	530,000	$181,188	$0.34
Ferrous Sulphate	530,000	$101,465	$0.19
Ferrous Fumarate	530,000	$126,106	$0.24
Iron EDTA	530,000	$ 84,071	$0.16
Ferrous Sulphate + Iron EDTA	530,000	$ 63,778	$0.12