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COP Paper
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COP Paper: Prevention of Iron Deficiency in Adolescent Female Athletes

Iron deficiency is a common problem worldwide in both developed and developing nations. the most recent data from Healthy People 2030, which is derived from the NHANES study data from 2015-2016, suggests that approximately 11% of females age 12-49 years old in the US have iron deficiency, which equates to approximately 1 out of 9 females of reproductive age in the US.[1] Iron deficiency can lead to iron deficiency anemia, which occurs when the body does not have sufficient iron for hemoglobin synthesis within red blood cells. This is relevant because inadequate hemoglobin in red blood cells decreases oxygenation of the body's tissues and can lead to symptoms like shortness of breath, fatigue, weakness, and chest pain.[2] Both of these conditions can have significant consequences in development, health, and quality of life of individuals. Particular groups of people are at increased risk for iron deficiency and include those assigned female at birth due to menstrual blood losses, pregnant individuals, children, adolescents, athletes, and those who face food insecurity. In female adolescent athletes specifically, the prevalence of iron deficiency has been estimated to be up to 15-35%.[3] The aforementioned group deserves special attention due to the intersection of multiple risk factors including age, female sex, and increased physical activity. In this paper, the importance of and potential approaches toward educating adolescent female athletes on prevention and awareness of iron deficiency will be discussed.

BACKGROUND

In order to understand why the populations described above are at an increased risk of experiencing iron deficiency as well as iron deficiency anemia, it is important to review the ways that these two conditions occur. Increased iron demand, decreased iron intake, chronic blood loss, and decreased iron absorption are all mechanisms by which individuals can become iron

deficient.[3] All of these mechanisms with the exception of decreased iron absorption concurrently contribute to iron deficiency in female adolescent athletes. More specifically, adolescents have an increased iron demand due to rapid growth, while females may also have increased blood losses compared with males due to menstruation.[4] Athletes often have decreased iron intake in the setting of dietary restriction.[2,3] Iron deficiency has been shown to be a negative consequence of Relative Energy Deficit in Sports, also known as RED-S, which is a common syndrome defined as an evident mismatch between energy intake and expenditure in athletes.[3] One cross-sectional study of 1000 female athletes found that those with RED-S had a 64% greater chance of developing low iron stores or anemia than those without RED-S.[5] In addition to inadequate intake, there are many other ways in which athletes acquire iron deficiency including sweating, inflammation, hemolysis, and hematuria.[6] Sports with a high training load such as running can make one even more vulnerable to iron deficiency than participation in lower impact sports. For the above reasons, adolescent female athletes will be the target population for my community outreach project.

Iron deficiency alone can negatively affect the body before one progresses to becoming anemic.[7] Iron deficiency without anemia can cause many symptoms that impact health status and quality of life, including but not limited to fatigue, decreased exercise tolerance, weakness, problems concentrating and low productivity with daily tasks and work.[2] These symptoms can be more profound in people who have progressed to iron deficiency anemia, because the body's ability to keep the tissues oxygenated is impaired when the body does not have sufficient iron for hemoglobin synthesis within red blood cells.

TREATMENT AND PREVENTION

Iron supplementation is an effective method to treat iron deficiency and subsequent anemia in many cases, and there are well-established recommendations for iron supplementation in the medical literature.[2] Constipation and dyspepsia are common side effects contributing to iron supplement intolerance. There are also setbacks of providing IV iron including cost, potential for infusion reactions, and lack of insurance coverage.[2] Iron deficiency can take anywhere from 3-6 months to reverse with proper intervention and supplementation. These drawbacks of treating iron deficiency anemia once it has already developed make community nutrition education for prevention of iron deficiency imperative.[2,8] By no means is it harmful to provide nutrition education once one has already developed iron deficiency anemia, but improving intake of iron-rich foods does not typically enough to replete iron stores once they are already depleted; supplementation will be required. Athletes who are diagnosed with iron deficiency anemia may benefit from seeing a registered dietitian who has the time, resources, and knowledge to help develop a personalized nutrition plan rather than participating in a more general group education session such as a community outreach project.

Prevention of iron deficiency and subsequent anemia through community education is one way to potentially improve health outcomes of adolescent female athletes. Community education could also save time, resources, and money that would otherwise go toward treating these conditions if they do develop. The positive impacts of preventative medicine have been widely recognized and include but are not limited to decreased disability, disease, and even death rates.[9]

EDUCATION SETTING

Education on disease prevention strategies can be delivered in a variety of different settings. The school setting has historically been a valuable place to implement health and

nutrition education programs.[10] The Oregon Health Standards and Performance Indicators are updated every school year by the Oregon Department of Education and set the bar for what schools should be preparing students to do in order to take care of themselves as they grow and develop.[11] These standards differ by grades, and grades 9-12 are included in the "high school" category. One pertinent standard listed is "HE.1.12.45: Explain key concepts of nutrition including food groups, nutrient types, adequacy of diet, portion size and moderation, food safety and disease connection." Educating a team of high school athletes on iron, the vital role it plays in the body, and how it is connected to chronic disease could complement the formal health education curriculum Forest Grove High School has in place for a subset of students at increased risk of iron deficiency – female athletes. Furthermore, not having to sign up for an additional class or stay late after school may be helpful for high school students who also participate in extra-curriculars and have a busy schedule.

PREVENTION EDUCATION STRATEGIES

When it comes to nutrition education in high schools, various education models have been successful. Khani Jeihooni et al. conducted a quasi-experimental study at a high school in which they utilized the PRECEDE model to provide nutrition education on iron deficiency to an experimental group (n=80) and compared both their nutritional knowledge and biomarkers with a control group of students (n=80).[12] This PRECEDE model has been introduced as a successful model in many clinical trials. In their study, Khani Jeihooni et al. measured the six PRECEDE model constructs which include knowledge, attitudes, self-efficacy, and predisposing, enabling, and reinforcing factors surrounding health behaviors. These constructs were measured with a pre- and post-study questionnaire taken by participants. Examples of predisposing factors are baseline knowledge and attitudes about the topic, while examples of enabling factors include

access to information and educational resources. Examples these researchers cited as reinforcing factors were the influence of family and school authorities on health behaviors. Khani Jeihooni et al. held six 45-50 minute education sessions which included the following topics: the role of iron in the body, the prevalence of iron deficiency in adolescent girls, importance of a nutritious diet and sources of dietary iron, ways that parents/guardians and schools can support adequate iron status in adolescents, ways to interpret nutrition information labels, and the impacts and consequences of iron deficiency. These sessions were concluded with a final session providing a review of the previous lessons at the very end of the curriculum. At four months, the experimental group showed a significant increase in nutritional behaviors that prevent iron deficiency anemia, which the control group did not exhibit. All six of the PRECEDE model construct scores listed above increased from the pre-intervention baseline in the experimental group ($p<.001$). The experimental group also had a significant increase in serum ferritin from their baseline average at the four-month mark while the control group did not ($p<.001$). The authors concluded that this school-based education model helped to improve behaviors that can prevent iron deficiency in teenage girls. The results of this study suggest that targeting several different iron deficiency-related topics and focusing on not only knowledge but also self-efficacy, attitudes, and enabling, predisposing, and reinforcing factors may be beneficial in prevention of iron deficiency. Wiafe et al. conducted a nonrandomized controlled trial with 137 adolescent participants from Ghana with the aim of exploring the impact of nutrition education on iron-rich food intake as well as knowledge of iron.[13] The researchers obtained information on baseline and post-intervention nutrition knowledge, a 24-hour diet recall, and sociodemographic information. They held six sessions over six months with different topics, including: iron function and importance, information about iron deficiency anemia, sources of dietary iron,

factors that aid in iron absorption, factors that decrease iron absorption, and a review of previous sessions. Wiafe et al. found that the mean knowledge score regarding iron-rich foods and signs and causes of anemia significantly higher in the intervention group than in the control group at the end of the study ($p<.05$). This evidence supports the idea that nutrition education on iron deficiency in a group setting can improve health knowledge which may in turn improve health outcomes.

CHOOSING A COMMUNITY GROUP

Careful consideration was taken regarding the specific target audience of this COP presentation. Although the research suggesting an increased risk of iron deficiency in high-impact athletes was discussed earlier, the impact of education on prevention of iron deficiency in female high school track runners specifically has not been well-researched at this time. However, this group is likely to benefit from education on iron deficiency prevention because it is a subgroup of the larger population of adolescent females as discussed above with an additional risk factor—high impact exercise. Having a smaller group of 20-30 students from one athletic team may also make the lesson more interactive than a lesson that involves a whole grade or school. Additionally, the CDC has emphasized the need for increasing the nutrition education provided for school-aged children and they support providing education in the school setting through multiple avenues instead of solely in the classroom.[10] The CDC healthy schools website states that "Nutrition education can be incorporated throughout the school day and in various locations within a school. This provides flexibility allowing schools to use strategies that work with their settings, daily schedule, and resources." Examples the CDC cites are farm-to-school programs, the cafeteria, and assemblies. Extra-curricular activities such as track practice are another creative way to provide nutrition education in a structured setting outside of the

classroom. I have already communicated with the Athletic director of a local high school, Forest Grove High School, and this community outreach project will tentatively be facilitated with their assistance as well as the coach of their Girls Track and Field Team.

CONCUSION

In conclusion, the prevalence of iron deficiency and subsequent anemia is high in at-risk populations such as female adolescent athletes. A large body of evidence, some of which was discussed above, suggests that nutrition education in a school setting can be effective in increasing knowledge about and in turn preventing iron deficiency anemia. The topics covered in my community outreach project presentation at Forest Grove High School will include a brief introduction to what iron is and it does for the body, risk factors for iron deficiency, and signs and symptoms to look out for. The presentation will include a discussion about action items – ways to obtain enough iron in the diet, information on affordable iron sources to pass along to parents and guardians, as well as when to reach out to a parent/guardian or medical provider if concerned about iron deficiency. Although the education I will be providing will be more abbreviated and condensed than the curricula described in the studies above, the goal of the project is to improve quality of life, concentration, athletic performance in the population I will be working with for my COP presentation.

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