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A FOOD-BASED APPROACH TO REDUCE VITAMIN A DEFICIENCY IN SOUTHERN ETHIOPIA: A CROSS-SECTIONAL STUDY OF MATERNAL NUTRITION AND HEALTH INDICATORS

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ABSTRACT

One micronutrient essential for proper growth and development is Vitamin A. Children and pregnant women are most susceptible to vitamin A deficiency (VAD) because of the higher intake requirements needed during critical growth periods. Vitamin A deficiency is a serious but preventable public health problem in Ethiopia. In 2012, the International Potato Center (CIP) partnered with the University of Wisconsin-Madison (UW) and local stakeholders in the Southern Nations, Nationalities, and Peoples Region (SNNPR), Ethiopia, to address the issue of VAD among rural SNNPR households by increasing production and consumption of orange fleshed sweet potatoes (OFSP). This paper presents a cross-sectional analysis of vitamin A knowledge, consumption practices, and OFSP agronomic practices from surveys conducted among households who participated in a food-based intervention. The study population consisted of 150 mothers from rural households in five districts in the Sidama and Wolayta zones in the SNNPR. Data were collected during April and May 2013 by trained enumerators in the local language using structured questionnaires. Surveys were adapted from validated instruments, and included questions about household socio-economic characteristics, agricultural practices, dietary diversity, food security, and general health for women between 20-60 years and children between 6-59 months. Among respondents, 63% of mothers reported knowledge about vitamin A, with responses varying by geographic location. Among those who reported knowledge about vitamin A, 8% identified OFSP as a source, 1% had consumed OFSP in the past 7 days, and 0% reported that they ever prepared OFSP with an animal- or vegetable-based fat. Vitamin A-related health issues reported by mothers include night-blindness (32%), measles (32%) and malaria (72%). Given that existing knowledge, behaviors and production levels of vitamin A rich foods (including OFSP) are limited within the SNNPR study population and vary by geographic location, an integrated, food-based approach to address VAD may be relevant in this context to sustainably support improved health and livelihoods.

Key words: Nutrition, orange fleshed sweet potato, behavior change, Ethiopia

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BACKGROUND

Improving nutrition, particularly for pregnant and lactating women and children under 5 years, is a crucial strategy to help countries achieve the Sustainable Development Goals (SDGs) [1]. Despite recent progress, many sub Saharan African (SSA) countries – including Ethiopia – continue to struggle with ensuring adequate nutrition for women and children, particularly in rural areas. Undernourished mothers face increased morbidity and mortality risks during pregnancy and childbirth, and children of undernourished mothers face greater challenges in life, both physically and cognitively [2, 3]. Undernourished children tend to have lower resistance to infections, a less resilient immune system, and are more likely to die from common childhood ailments [4]. Children who do survive to adulthood may experience impaired development that sets them behind throughout life. Malnutrition holds people back from achieving their full potential, which not only impacts individuals and their families, but also has consequences on whole communities and national development [5]

In 2012, the International Potato Center (CIP) partnered with the University of Wisconsin-Madison (UW) and local stakeholders from the Southern Nations, Nationalities, and Peoples Region (SNNPR), Ethiopia, to implement a food-based approach to reduce vitamin A deficiency (VAD) among rural households (HHs) in five districts of Sidama and Wolayta zones. This article summarizes the prevalence of maternal undernutrition and health indicators among five *woredas* in SNNPR, Ethiopia. The objectives of this study were to describe the prevalence of vitamin A knowledge, consumption practices, and health behaviors among mothers; and to identify program strategies to inform the design of a food-based approach to reduce VAD that are culturally and contextually relevant.

Context of Vitamin A Deficiency

One micronutrient essential for proper growth and development is vitamin A. Vitamin A plays a critical role in eye health, vision, proper immune system functioning, growth, and development in all human beings [6]. Children and pregnant women are most susceptible to VAD because of its dependency on balanced nutrition for adequate absorption and the fact that higher intake levels are needed during critical growth periods. Globally, VAD affects 33.3% of preschool-age children and 15.3% of pregnant women, with certain geographic areas more affected than others [7]. The highest prevalence and burden of VAD is in developing regions, such as sub-Saharan Africa, where malnutrition is prevalent and food security is low [8, 9]. To address VAD, the World Health Organization (WHO) recommends a three-pronged approach including supplementation, food fortification, and diet diversification [10]. Given the multi-faceted impacts of VAD, a food-based approach that emphasizes consumption of vitamin A rich foods is encouraged as a strategy to reduce VAD as a means to support sustainable livelihoods [11, 12]. In particular, the use of orange fleshed sweet potato (OFSP), when introduced along with nutrition education at the community level, is a proven, cost-effective strategy for providing vitamin A at high levels of bioavailability to vulnerable populations [13, 14].

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Community Context

The International Potato Center, founded in 1971 as an international research-for-development institution, is committed to "achieving food security, improved well-being, and gender equity for poor people in root and tuber farming and food systems of developing world." It is a member of the Consultative Group for International Agricultural Research (CGIAR), which has offices in 30 countries across Asia, Africa, and Latin America, and works with interdisciplinary partners from agriculture, nutrition, the social sciences, economics, the health sciences, and policy to support multi-sector approaches to reducing poverty and food insecurity. The International Potato Center has implemented projects emphasizing improved agricultural production of root and tuber crops in Ethiopia since the mid-1980s. The organization has paid particular attention to improving the production and consumption of orange fleshed sweet potato (OFSP) in multiple SSA countries, and has played a key leadership role in developing integrated agriculture, nutrition, and health programs that utilize a food-based approach to improve nutrition and health outcomes [15]. The orange fleshed sweet potato was selected as a strategy crop because of its potential to produce high crop yields per area under production in a relatively short period of time, has a higher drought tolerance, and can be grown under more diverse elevations and soil types than other crops such as maize [16]. In Ethiopia, sweet potato is an important crop consumed by households and sold in markets in multiple regions of the country. White-fleshed sweet potato (WFSP) is a staple food crop for an estimated 13 million people in the SNNPR, while OFSP is a relatively new crop that has been introduced for its nutritional benefits and higher yields [16].

In 2010, with funding from Irish Aid, CIP initiated its first integrated agriculture and nutrition program in the Tigray region (northern Ethiopia), with the goal of increasing the production and consumption of micronutrient-rich OFSP to reduce VAD and improve nutrition and health outcomes among smallholder farmers and their households. In 2012, CIP launched another program in the SNNPR region of Ethiopia with multi-sector stakeholders from agriculture, nutrition and health to achieve the goals of improved production and consumption of potato and OFSP as part of nutritious, diversified diets. The project worked in 5 districts in 2 SNNPR zones, Sidama and Wolayta, both of which are characterized as being very rural, having high population densities, and experiencing high prevalence of food insecurity.

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Figure 1: Map of Ethiopia's Southern Nations, Nationalities, and People's region. CIP project zones – Wolayta and Sidama – are highlighted in red Source: Geocommunity [32]

The SNNPR is characterized by a diverse agro-ecology, relatively high population density, exposure to recurring drought, and erratic rain patterns [17]. Generally, crop yields are low and the majority of the population, particularly women and children, continue to face high levels of poverty, hunger, chronic food insecurity, and widespread malnutrition, in spite of ongoing donor programs designed to address these issues [18].The SNNPR accounts for 20% of Ethiopia's total population, of which over 90% live in rural areas and depend upon agriculture for their livelihoods [19]. Thirty percent of the population lives below the national poverty line, nearly 1(one) million people are chronically food insecure, and 98,000 people required emergency humanitarian assistance in 2013 [20]. The SNNPR also records one of the highest under-5 mortality rates in Ethiopia, with one in eight children expected to die before their fifth birthday [21]. According to the mini DHS 2014 Ethiopian Health and Demographic Survey, stunting and underweight rates among children under-five were 40% and 25%, respectively, while prevalence of wasting remained constant, at close to 10% over the last 10 years [21]. Inadequate diets are one contributor to this, and micronutrient deficiencies are widespread [22]. According to the 2011 national health survey, only 35% of children and 61% of women consume foods rich in vitamin A and only 44% of children 6-59 months were able to access full vitamin A supplementation coverage. Furthermore, national nutrition surveillance data show that only 4% of children 6-23 months in SNNPR are fed in accordance with standard Infant and Young Child Feeding (IYCF) practices. Some progress has been made in reducing stunting and underweight; however, consumption of foods rich in vitamin A declined between 2000 and 2005, and has remained constant over the past five years.

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METHODS

The study population consisted of 150 mothers from rural households in five districts in the Sidama and Wolayta zones in the SNNPR. Data were collected during April and May 2013 by trained enumerators in the local language using structured questionnaires. The surveys gathered information on household socio-economic characteristics, education levels, agricultural practices, potato and OFSP production and consumption habits, food security, nutritional status, and general health for women and children between 6-59 months. Questions were adapted from validated survey instruments from the Household Income and Expenditure Survey (for household resources and characteristics), Helen Keller International Nutrition Survey (for nutrition and vitamin A-related questions), UNICEF (for maternal and child health questions), and the Food Nutrition and Technical Assistance Project (FANTA).

Households were selected as part of the study having met the following criteria: located within study area; proximity to a main road; contained primary targets of food security interventions, which were mothers (age 20-60 years) of children aged 6-59 months and at least one child aged 6-59 months; and approval of elders. Ethical approval was obtained from the Institutional Review Board at the University of Wisconsin-Madison. Verbal consent was obtained in the local language and collected from each household head prior to collecting data. Quantitative analysis of data was conducted using SAS® version 9.2.

The surveys collected socio-economic and demographic data (table 1) as well as information about maternal vitamin A knowledge, behaviors, nutrition, and health to understand current conditions and help inform program design (table 2). This is because other studies found multiple determinants to impact individual dietary choices, but factors that most directly influence fruit and vegetable consumption are gender, age, socioeconomic status, nutrition knowledge, personal and cultural food preferences, parental intake/role modeling, and availability [23]. Because various factors influence food choices, CIP recognized that designing and implementing multi-component nutrition education strategies guided by social and behavioral theory may be more successful in improving OFSP consumption [24, 25, 26]. In particular, Social Cognitive Theory (SCT) addresses both psychosocial dynamics influencing health behaviors and methods for promoting behavior change [23, 27]. Specific activities used by community-based nutrition programs that incorporate SCT include observational learning, self-efficacy, and knowledge change [28].

Statistical Analysis:
Data were entered into a RedCAP® database and checked for missing values and outliers. Mothers' knowledge about vitamin A, nutrition behaviors, production of potato, white fleshed sweet potato, and OFSP, and health status indicators with continuous variables were compared across the five administrative districts using analysis of variance (ANOVA) to identify potential associations. Indicators with categorical variables were compared using Chi-Square tests. P-values <0.05 were considered as significant. All tests were performed using SAS® version 9.2 software (SAS Institute, Cary, North Carolina).

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RESULTS

The mean current age of mothers was 36.4 years (table 3). The average age at marriage was 16.9 years, and at first pregnancy was 17.8 years. Within this study population, the mean number of times women were pregnant was 6.1 times.

Among mothers, 63% self-reported knowledge about vitamin A (table 4). However, mothers' reported knowledge varied based on geographic location, with the lowest reported knowledge of vitamin A in Damot Gale (25%) and the highest in Boricha and Loko Abaya (both 87%). Among those who reported knowledge about vitamin A, 8% could identify OFSP as a source and 71% could not identify any food source of vitamin A. Notably, when mothers did know about vitamin A, almost all of them were able to identify it was important for good health. Among all mothers, only 1% had consumed OFSP in the past seven days, and none reported that they ever prepared OFSP with an animal- or vegetable-based fat (table 5).

Within this population, more than half of households grew potatoes (63%) and about one-third (36%) grew WFSP in the last 12 months (table 6). However, maternal consumption of these products was limited, with only 15% of households consuming potatoes in the last seven days and 9% of households consuming WFSP. The household surveys included spaces for respondents to explain why they did not produce or consume these crops. Some of the reasons reported include seasonal production of the crops, poor post-harvest handling practices, lack of long-term storage options, limited knowledge on ways to preserve potato and WFSP crops, and lack of value-added processing. There was low prevalence of OFSP production (7%) and consumption among all districts. Given that other root crops are grown, there is an opportunity to increase farmer production and consumption of OFSP. The barriers to producing and consuming OFSP must be better understood, as those barriers may differ from the reasons for potato and WFSP. Additionally, there were statistically significant differences in the prevalence of potato production between districts.

There are high rates of vitamin A supplementation among all districts. However, vitamin A-related health issues remain high among mothers, including night-blindness (32%), measles (32%), diarrhea (32%), and malaria (72%) (table7).

DISCUSSION

Within the SNNPR study population, existing knowledge about vitamin A, nutrition behaviors, and production levels of vitamin A rich foods (including OFSP) are limited and vary by geographic location. However, it is a region with agro-ecologies suitable for farmers to produce high yields of OFSP, and provided a suitable context for CIP to implement program activities using a food-based approach in a region with a known high prevalence of VAD. Examples of approaches to combat VAD in developing regions include a natural, food-based method, including the consumption of yellow/orange crops and dark-green leafy vegetables, direct supplementation, and bio-fortification [29]. Although studies have reported cases in which each approach has proven successful, multi-faceted and correlated factors must be taken into

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consideration. Such considerations include education levels, available resources and who has access to them, and long-term sustainability in relation to program costs, agro-ecologies, and social and cultural systems [30].

A meta-analysis published by Berti *et. al*. [29] reviewed and analyzed the characteristics and impacts of thirty agricultural interventions on nutritional status. Of the thirty projects reviewed, twelve of the projects were based in northeast Africa, fourteen in southern Asia, and four in the Americas. The studies were analyzed based on intervention type, study design, agricultural and nutrition indicators and outcomes, and conclusions. They were also analyzed taking into account five types of capital: natural, physical, human, social, and financial. The Sustainable Livelihoods Framework, a conceptual map of factors that affects people's livelihoods and relationships, emphasizes that these five assets must be supported and strengthened through any development intervention in order for it to be successful [31]. The reviewers were confident in the conclusions of 17 of the 30 studies. Nine of the 17 showed improvement in at least one agricultural factor. All nine of these cases used the home gardening approach. The home gardening interventions invested more types of capital than the other approaches, including gender consideration, which may have been responsible for the positive effect on child nutrition, vitamin A status, and morbidity. Nineteen interventions had a positive effect on nutrition, and of these 14 had invested in four or five types of capital in addition to the agriculture intervention. Finally, of the nine interventions that had a negative or no effect on nutrition, only one invested in four types of capital. The findings suggest that all five capitals need to be strengthened by interventions, with a focus on education and gender issues, to improve nutritional outcomes and to have a long-term positive effect.

Increasingly, the food-based approach is encouraged as part of an integrated set of strategies to address micronutrient deficiencies because of the potential to support sustainable livelihoods by accompanying policies which increase income and assets, promote environmental stewardship, increase social capital, and address issues of gender equity and empowerment in addition to improving nutrition and food security. Food-based approaches are safe at any dose for anyone, including pregnant women and children with normal vitamin levels. Low-income populations that have high prevalence of vitamin deficiencies tend to have monotonous diets consisting of staple foods. A food-based approach, which provides variety, has the advantage of not only eradicating vitamin A deficiency, but also improving the status of other essential nutrients, rendering them optimal in low-income populations, which likely have high prevalence of other deficiencies, as well. Financially, as compared to supplementation, food-based approaches promote self-sufficiency and food security, while supplementation approaches promote further dependency on the government and other institutions. Despite these benefits of food-based approaches, they also have challenges to implementation. These challenges include the amount of time they require to set-up; specialized human knowledge and capacity to deliver an integrated set of agronomic and nutrition trainings; suitable political, cultural, and natural environments where households have sufficient land and the right climate to grow diverse foods to meet their dietary needs; and effective partnerships with adequate financial resources to establish evidence-informed strategies that reflect local cultural and contextual drivers

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of micronutrient deficiencies. Food-based approaches should be viewed as part of an integrated set of strategies, but depending on the local drivers and population affected by micronutrient deficiencies, other strategies (for example, supplementation) may be more suitable.

One of the aims of the CIP OFSP project is to help smallholder farmers increase production of OFSP and in turn increase household consumption. Thus, it is helpful to consider what factors may promote or hinder a food-based approach within the SNNPR context. Because the households within this study site have limited resources, activities that can strengthen multiple types of capital and build upon existing assets may be more appropriate and sustainable.

The International Potato Center is working to enhance this knowledge and capacity by incorporating qualitative and participatory studies to assess changes in knowledge, attitudes and practices; conducting integrated agronomic and nutrition workshops; and taking a Training of Trainers (TOT) approach to build capacity among local agriculture and health workers. Findings have also informed and reinforced CIP's nutrition activities in ways that are responsive to the community context. For example, design of cooking demonstrations that feature regionally specific foods, OFSP promotion activities at community festivals, conducing nutrition education through women's groups, delivery of nutrition education by local health extension workers, and engaging youth through school gardens and school-based science clubs.

Limitations: the findings of this survey may not be applicable in other regions of Ethiopia and production and consumption prevalence would likely be different had the surveys been conducted at a different time of the year. Data from these surveys were collected at the end of the *belg* season (February-May), which is the secondary harvest season in the SNNPR. Food stocks tend to be lower at this time of year as households wait for seasonal rains (June-September) to irrigate their main harvests that fall in the *meher* season (June-September). In order to enhance understanding of these data, semi-annual surveys are to be conducted at six-month intervals to capture seasonal food security and dietary diversity patterns. The descriptive statistics indicate limited vitamin A knowledge, low knowledge about and consumption of vitamin A-rich foods, and limited production of OFSP across all districts within the study population. However, prevalence varied significantly within the five *woredas,* and though it is beyond the scope of this study, it would be helpful to further explore what place-related factors influence maternal behaviors and health outcomes. Additionally, follow-up qualitative surveys may help capture mothers' understanding of the questions, what they see as constraints to good nutrition and health, and how seasonality (and other factors) impacts their food choices and health. Having this kind of data would shift the quantitative findings away from only capturing prevalence toward an understanding of the local conditions, factors, and experiences of the community to tailor nutrition programs and policies that meet their concerns.

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CONCLUSION

The best method of alleviating vitamin A deficiency is relative to the situation and resources available. A food-based approach is encouraged when possible because it has the potential to enhance multiple types of capital, which may decrease morbidity and other vitamin deficiencies beyond vitamin A. Long-term nutrition and health improvements require dietary diversification, including increased consumption of vitamin A-rich foods, along with enhancement of other livelihoods assets in order to be sustainable and effective. Given that existing knowledge, behaviors, and production levels of vitamin A-rich foods (including OFSP) are limited within the SNNPR study population, an integrated food-based approach may be most relevant in this context to support improved health outcomes and sustainability. To achieve this, families must be informed, motivated, and empowered on how to incorporate vitamin A-rich foods into their diets throughout the year.

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Table 1: Profile of households (n = 150) from the Southern Nations, Nationalities, and Peoples' Region study population

Average household size (number of people)	6.9
% of female-headed households	5%
Household head mean age (in years)	44
Mean age of mothers (in years)	36
Household head education	
Illiterate	32%
Read and write	4%
Primary	33%
Secondary	26%
Vocational	5%
Mean cattle owned	2.9
Mean land owned (in timad*)	3.9
% food insecure households	88%

** Four timad = 1 hectare*

Table 2: Maternal Vitamin A Nutrition and Health Indicators

Maternal Vitamin A Knowledge	- Knowledge about Vitamin A (VA)
	- Ability to identify any VA-rich food
	- Knowledge that VA supports health
	- Ability to identify any health benefit of VA
Maternal Vitamin A Behaviors	- Consumption of OFSP in last 7 days
	- Prepare and/or consume OFSP with animal- or vegetable-based fat
Household Vitamin A Production	- Production of P, WFSP, and OFSP in last 12 months
Maternal Health Status	- Received antenatal care
	- Mother and child VA supplementation
	- Measles
	- Malaria
	- Diarrhea in past 30 days
	- Sickness in past 30 days
	- History of night-blindness and/or eye disorder

WFSP- White fleshed sweet potato
OFSP- Orange fleshed sweet potato

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Table 3: **Profile of mothers (n = 150)**

Current age of mother (years)	36.4
Age of mother at marriage (years)	16.9
Age of mother at first pregnancy (years)	17.8
Number of times pregnant	6.1
Number of children still alive	5.5
% of mothers who gave birth in a health care facility	2%

Table 4: Comparison of maternal knowledge about vitamin A, by *woreda*(district)

	Sidama Zone (n=60)		**Wolayta Zone (n=90)**			**Overall (n=150)**
	Boricha	Loko Abaya	Damot Gale	Damot Woyide	Dugunafango	
Know about vitamin A***	87%	87%	25%	56%	62%	63%
Among those who know about vitamin A, can identify the following food sources:						
OFSP***	7%	0%	25%	6%	0%	8%
Dark leafy greens*	7%	0%	21%	16%	10%	11%
Meat/liver/eggs***	10%	0%	32%	13%	7%	12%
Carrots*	10%	0%	18%	19%	10%	11%
Chilies**	7%	3%	39%	22%	23%	19%
Could not identify a food***	87%	87%	43%	69%	67%	71%
Among those who know about vitamin A, can identify that it is important for health:						
Knowledge of VA and health	97%	96%	95%	94%	98%	96%

* $p<0.05$
** $p<0.01$
*** $p<0.001$

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Table 5: Comparison of maternal consumption of potato products in last 7 days, by *woreda* (district)

	Sidama Zone (n=60)		Wolayta Zone (n=90)			Overall (n=150)
	Boricha	Loko Abaya	Damot Gale	Damot Woyide	Duguna Fango	
None*	90%	90%	68%	78%	87%	85%
Potato**	10%	3%	32%	22%	7%	15%
White fleshed sweet potato*	0%	3%	18%	16%	7%	9%
OFSP	0%	0%	0%	3%	0%	1%
When you do consume OFSP, do you ever prepare it with a vegetable- or animal-based fat?						
Prepare OFSP with fat	0%	0%	0%	0%	0%	0%

** $p<0.05$*
*** $p<0.01$*
OFSP- Orange fleshed sweet potato

Table 6: Comparison of households that produced potatoes, white fleshed sweet potatoes, and orange fleshed sweet potato (OFSP) in the last 12 months

	Sidama Zone (n=60)		Wolayta Zone (n=90)			Overall (n=150)
	Boricha	Loko Abaya	Damot Gale	Damot Woyide	Duguna Fango	
Potato***	80%	17%	68%	69%	80%	63%
White fleshed sweet potato***	40%	30%	25%	41%	43%	36%
OFSP***	13%	0%	18%	3%	4%	7%

****$p<0.001$*

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Table 7: Comparison of maternal health status indicator, by *woreda* (district)

	Sidama Zone (n=60)		**Wolayta Zone (n=90)**			**Overall (n=150)**
	Boricha	Loko Abaya	Damot Gale	Damot Woyide	Duguna Fango	
Maternal health practices						
Ever received antenatal care*	94%	93%	83%	80%	85%	87%
Mother took VA supplement after giving birth**	100%	93%	83%	85%	95%	91%
Child received VA supplement within week of birth	94%	100%	100%	100%	100%	99%
Maternal health outcomes						
History of eye problems***	20%	13%	37%	17%	40%	25%
History of night blindness***	22%	15%	49%	19%	59%	32%
Ever had malaria***	63%	80%	93%	69%	55%	72%
Diarrhea in last 30 days***	43%	27%	41%	28%	38%	35%
Sick in last 30 days***	47%	23%	64%	44%	35%	43%
Has a chronic illness***	17%	7%	18%	13%	21%	15%

** $p<0.05$*
*** $p<0.01$*
****$p<0.001$*
VA = Vitamin A

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