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Research Application Summary

Trends in iodine nutrition in Uganda since the inception of the Universal Salt Iodization programme

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Abstract

Deficiency of iodine in humans leads to a range of health defects, referred to as iodine deficiency disorders (IDD). Since 1994, a universally recognised strategy of mass fortification of edible salt with iodine, codenamed USI Programme, has been implemented in Uganda to ensure optimal human iodine intake. Evidence on the impact of this intervention remains fragmented. The objective of this review is to assess the impact of the Ugandan USI Programme on the population since its inception. We used data from surveys that assessed iodized salt coverage and the prevalence of IDD and iodine deficiency for the period of 1994-2019.Findings revealed that over 90% households used iodized salt after five years of implementation of the programme. This progress translated into dramatic reduction of goiter rate, but led to excessive iodine intake due to over-iodization in the first 10 years. Although updated national data on iodine nutrition status is lacking, recent findings from a sub-regional study revealed a high prevalence of iodine deficiency, suggesting a likely recurrence of inadequate iodine intake in the country, despite wide practice of salt iodization. From this review, it is clear that high iodization coverage does not necessarily translate into expected optimal iodine intake. The review reveals the importance of rigorous and regular monitoring of iodine use to minimise incursion of latent IDDs among communities.

Keywords: Edible salt, Iodine deficiency disorders, iodization, Uganda

Résumé

La carence en iode chez l'homme entraîne une série de problèmes de santé, appelés troubles de la carence en iode (IDD). Depuis 1994, une stratégie universellement reconnue d'enrichissement de masse du sel comestible en iode, nom de code USI Programme, a été mise en œuvre en Ouganda pour assurer un apport humain optimal en iode. Les preuves de l'impact de cette intervention restent fragmentaires. L'objectif de cette revue est d'évaluer l'impact du programme USI ougandais sur la population depuis sa création. Nous avons utilisé les données d'enquêtes qui ont évalué la couverture en sel iodé et la prévalence des TDCI et des carences en iode pour la période 1994-2019. Les résultats ont révélé que plus de 90 % des ménages utilisaient du sel iodé après cinq ans de mise en œuvre du programme. Ces progrès se sont traduits par une réduction spectaculaire du taux de goitre, mais ont conduit à un apport excessif en iode dû à une sur-iodation au cours des 10 premières années. Bien que des données nationales actualisées sur l'état nutritionnel en iode fassent défaut, les conclusions récentes d'une étude sous-régionale ont révélé une prévalence élevée de carence en iode, suggérant une récurrence probable d'un apport insuffisant en iode dans le pays, malgré une large pratique de l'iodation du sel. D'après cet examen, il est clair qu'une couverture élevée en iodation ne se traduit pas nécessairement par un apport optimal en iode attendu. L'examen révèle l'importance d'un suivi rigoureux et régulier de l'utilisation de l'iode pour minimiser l'incursion des TDCI latents parmi les communautés.

Mots-clés : Sel comestible, troubles liés à la carence en iode, iodation, Ouganda

Introduction

Iodine is an essential micronutrient for human nutrition as an integral component of thyroid hormones which regulate metabolism. An estimated two billion people (38%) worldwide have inadequate intake of this mineral, mainly in low income regions of the world (Andersson *et al.,* 2012). Women of reproductive age and children are the most predisposed due to their augmented physiological needs (Chandra, 2015). Inadequate intake of this mineral results into a range of health consequences, collectively termed as Iodine Deficiency Disorders (IDD). The most detrimental IDD is mental retardation in children, which leads to reduced intellectual ability, low educational attainment and productivity later in life (WHO, 2007). IDD also include goiter, stunted growth, hypothyroidism, cretinism, miscarriage and stillbirths; contributing significantly to increased child mortality.

Iodine is unevenly distributed in the earth's environment and occurs mainly in seawater (Fuge, 2013). In regions far from oceans, inland areas, mountainous areas and regions with frequent floods, the cycle of iodine is slow or incomplete, making it impossible to recycle it in the soil and water (Zimmermann and Trumbo, 2013). As a result, crops grown in iodine deplete areas contain less iodine, making consumers prone to iodine deficiency (Bukania *et al.,* 2019). A typical example is the case of Uganda, which is classified among regions with naturally low soil iodine (Rohner *et al.,* 2014). Over the last three decades, a number of interventions have been promoted to increase dietary iodine intake, including majorly mass fortification of table salt with iodine, food fortification, iodine supplementation and agronomic iodine biofortification. The strategy of mass fortification of edible salt, commonly known as Universal Salt Iodization (USI), is globally acknowledged as the most effective intervention to ensure adequate iodine intake for nearly all individuals for the reason that this commodity is consumed on a daily basis and in constant amounts, regardless of households' background (Zimmermann *et al*., 2008). In fact, this intervention has resulted in a dramatic increase in household consumption of iodized salt, from less than 20% in 1990 (UNICEF, 2008) to 86% households by 2016 (WHO, 2019) and to 88% by 2019 (UNICEF, 2019) worldwide.

In 1994, Uganda adopted mass fortification of salt with iodine. Information on the impact of this effort is scattered in different reports, thus requiring consolidation in order to inform policy. The objective of this review was, therefore, to analyse the performance of the USI programme in Uganda since its inception in 1994.

Evolution of iodized salt coverage in Uganda. Table 2 summarises findings from seven studies of which five were Demographic and Health Surveys (DHS) that assessed national iodization coverage and two independent surveys since 1995.

Table 2. Iodization coverage over the last two decades in Uganda since 1995

	Definition of USI coverage used			
Type of study, year	Total number of households (N)	Households with iodized salt (%)	Households with adequately iodized salt (%)	Source
DHS, 1995[a]				
National	8,093	-	69	Statistics department (1996)
Urban		-	88	
Rural		-	62	
Stand-alone survey, 1999b,[1]				
National	300	-	63.8	Bimenya *et al*. (2002)
DHS, 2001[a]				
National	7,885	-	94.8	UBOS (2001)
Urban	1,174	-	98.8	
Rural	6,711	-	94.1	
DHS, 2006[a]	7,874	-	95.8	UBOS (2007)
National	1,186	-	98.7	
Urban	6,688	-	95.3	
Rural				
DHS, 2011[a]	8,263	99.0	-	
National	1,488	98.7	-	UBOS (2012)
Urban	6,775	99.1	-	
Rural				
Stand-alone survey, 2015[c]	818	99.5	97.0	
National	389	99.5	97.4	Knowles *et al*. (2017)
Urban	429	99.6	97.0	
Rural				
DHS, 2016[a]	17,851	99.4	-	UBOS (2018)
National	4,533	99.6	-	
Urban	13,318	99.3	-	
Rural				

- [a]Iodine in salt analysed using rapid test kits; [b]Iodine in salt analysed using iodometric titration; [c]Iodine in salt analysed using rapid test kits; [1]adeqately iodized salt was defined as salt with ≥50 mg iodine per kg; - represents not applicable; UBOS: Uganda Bureau of Statistics.

Iodized salt coverage has been documented mainly through nationally representative DHS. In the 1995, 2001 and 2006 DHS, iodine content in salt was estimated using rapid test kits (RTK) and the coverage was reported as households using adequately iodized salt (69, 94.8 and 95.8% respectively). Adequately iodized salt was defined as salt containing iodine 25 ppm in the 1995 DHS; whereas 15 ppm was the level used for 2001 and 2006 DHS. The coverage was reported as the proportion of households using iodized salt (with any iodine content) in the 2011 DHS (99%), as well as the latest 2016 DHS report (99.4%).

In 1993, Bimenya *et al*. (2002) conducted a study in six districts across the Uganda to monitor the progress of the USI programme. Using a titration method, 293 household salt samples were analysed quantitatively for iodine content and the coverage of adequately iodized salt was 63.8%. Knowles *et al*. (2017) assessed the iodized salt coverage in Uganda and other nine developing countries. This study used iCheck device to determine iodine content in salt. Results showed that the proportion of households which used salt iodized with any iodine concentration was 97%; whereas that of adequately salt iodized was 95%. Generally, no disparity was noted in accessing iodized salt in Uganda based on residential location of households, except in the 1995 UDHS whereby the urban households were more likely to have iodized (88%) than rural households (69%) (Knowles *et al*., 2017).

One of the key USI success indicators is to achieve 90 households consuming adequately iodized salt (UNICEF, 2018). However, data collected on iodization coverage during previous Uganda DHS reflect the proportion of households using salt iodized with any iodine. This is because these studies have widely used RTK which are qualitative and not quantitative even if the 1995, 2001 and 2006 DHS used these kits to report wrongly the proportion of households with adequately iodized salt. Several study reports have discouraged the use of RTK for estimating the levels of iodine in salt after confirming their unreliability to determine quantitively iodine content (Dary, 2011;Gorstein *et al*.,2016; Lench *et al*., 2017). It is, therefore, imperative to consider alternative quantitative procedures such as titration in future monitoring studies in order to report accurately on not only iodized salt coverage but also on the iodization adequacy.

Changes in iodine nutrition in Uganda. Following the introduction of a legislation mandating fortification of salt with iodine, Uganda has recorded impressive progress in reduction of IDD. Findings of studies that assessed iodine nutrition status since 1991 are summarised in Table 3.

A study conducted in 1991, three years prior to launching USI programme, in four endemic districts (Kisoro, Bundibugyo, Hoima and Kapchorwa) reported a total goiter rate of 74.3% and the visible goiter of 39.2% based on a sample of 1523 school-aged children (Kakitahi and Olico-Okui, 1991). Still in the same year, a sub-national survey undertaken in Masindi district among 2,032 children aged 11-13 years, revealed that 44% had goiter (Owarw, 1993). In 1999, Bimenya *et al*. (2002) evaluated the progress of the USI programme using a sample of 2870 randomly selected school-age children from 72 primary schools across the country. The authors noted a decline in total goiter rate standing at 60.2% and visible goiter at 30%, down from 74.3% and 39.2%, respectively. This improvement was attributed to wide consumption of iodized salt. The same study used a subsample of 293 children to assess dietary iodine intake using UIC and only 5% had low iodine intake. However, the overall mUIC of 310 μg/L was outside the acceptable range of 100–299 μg/L for adequate iodine intake, indicating an excessive iodine intake in the community. This excess

Table 3. Prevalence of iodine deficiency and IDD in Uganda from 1991 to 2019

			Method used to assess iodine nutrition								Source
Year of survey	Scope	Population surveyed	Serum THS		Thyroid enlargement (Goiter)			Urinary Iodine Concentration			
			N	Presumptive IDa (%)	N	Population with) visible goiter (%)	Population with total goiter (%)	N	Median UIC (μgL^{-1})	Population with UIC<100μgL^{-1} (%)	
1991	Western Uganda	>10 years	-	-	1523	39.2	74.3	-	-	-	Kakitahi and Olico-Okui (1991)
1991	Massindi district	11-13 years	-	-	2032	44	-	-	-	-	Owarw (1993)
1999	Nation wide	6-12 years	-	-	2870	30	60.2	293	310	5b	Bimenya *et al*. (2002)
2005	Nation wide	6-12 years	-	-	-	-	-	3260	463.8	3.9	Olico-Okui (2005)
2008	Western Uganda	3-7 days	1078	23.4	-	-	-	-	-	-	Ehrenkranz *et al*. (2011)
2019	Acholi Subregion	6-12 years	-	-	-	-	-	192	129	37.3	Ajambo *et al*. (2019)
		15-49 years (WRA)	-	-	-	-	-	310	141	30.7	

N = Sample size; WRA: Women of Reproductive Age; aPresumptive iodine deficiency is defined by the percentage of newborn with Tyroglobulin >5 mlU/L; bInsufficient UIC was defined as 50µgL-1as per the actual WHO cut-off.

iodine intake could have resulted from salt iodization beyond the requirements. In this study, 63.8% of households had salt with iodine content of 50 ppm as per the actual national standards for food grade salt.

In 2005, a country-wide survey was conducted to determine the prevalence of iodine deficiency using UIC among school children aged 6-12 years (n=3260), selected from 119 schools in four geographic regions (East, West, North and central). Results revealed that only 4% had low dietary iodine intake (100 µg/L), slightly below that of the 1999 survey (5%); although the cut-off of 50µgL-1 used in the latter might have underestimated the percentage of children with low iodine intake (Bimenya *et al*, 2002; Olico-Okui, 2005). Also, the overall mUIC among the study population was as high as 464 µgL-1, well above the WHO threshold of 299 µg/L beyond, which intake is considered as excessive in a given community. Following these findings, recommendations were made to cut iodization levels in order to avoid risks of potential health effects.

A study conducted in 2008 by Ehrenkranz *et al.* (2011) in Western Uganda examined the iodine nutrition status among new born babies using serum Thyroid Stimulating Hormone (TSH) marker. The authors reported a prevalence ranging from 20 to 32% in the five districts covered (Bundibugyo, Kabarole, Kasese, Kisoro and Kabale). This finding evidenced the presence of presumptive iodine deficiency among pregnant mothers in western Uganda, which is defined by a prevalence range of 20-40% of neonates with TSH >5 mIU/L. At that point, 95% of edible salt available in the country was fortified with iodine (UBOS *et al*., 2012).

Recent findings in Gulu and Lira districts of Acholi subregion in northern Uganda revealed a high prevalence of inadequate iodine intake standing at 30.7 and 37.3%, among school going children and women of reproductive age, respectively; whereas the mUIC for SAC was within the optimal range (129µgL-1) (Ajambo *et al*., 2019). It should be noted that the high prevalence of iodine deficiency was found in the area where virtually all households accessed iodized salt (Acholi subregion: 99.4%) (UBOS, 2018). This makes iodine content in salt questionable and stresses the need to shift from using the coverage of iodized salt to using the coverage of adequately iodized salt when it comes to monitor USI program in Uganda.

Conclusion

Impressive progress has been made to control IDD notably reduction of goiter rate and this has been attributed to considerable progress made in increasing iodized salt coverage over the last two decades in the country. However, by assessing iodine nutrition using more sensitive methods such as UIC, it is clear that achieving adequate iodine intake has been a challenge. This is well illustrated by excessive iodine intake revealed in 2001 (mUIC=141 µg/L) and 2005 (mUIC=463.8 µg/L), as well as high prevalence of inadequate iodine intake as reported in 2019 in Acholi Subregion amidst wide iodization coverage. The trend in Uganda shows that achieving high coverage in iodized salt may not necessarily result in optimal iodine nutrition among consumers and this leaves a gap on the extent to which iodine levels in household salts are adequate. There is need for rigorous and regular monitoring of USI programme to prevent resurgence of invisible IDD cases among communities. This should involve both assessing iodine nutrition status and ascertaining the iodization adequacy of household salt using a golden quantitative method such as iodometric titration.

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References

Ajambo, M. 2019. Prevalence and factors associated with iodine deficiency among children aged 6-12 years and women of reproductive age in Gulu and Lira districts. Master's Thesis, Gulu University, Gulu, Uganda.

Bimenya, G.S., Kaviri, D., Mbona, N. and Byarugaba, W. 2002. Monitoring the severity of iodine deficiency disorders in Uganda. *African Health Sciences* 2 (2): 63-68.

Ehrenkranz, J., Fualal, J., Ndizihiwe, A., Clarke, I. and Alder, S. 2011. Neonatal age and point of care TSH testing in the monitoring of iodine deficiency disorders: Findings from western Uganda. *Thyroid* 21 (2): 183-188.

Fuge, R. 2013. Soils and iodine deficiency. pp. 417-432. In: Essentials of Medical Geology. Springer, Dordrecht.

Gorstein, J., van der Haar, F., Codling, K., Houston, R., Knowles, J. and Timmer, A. 2016.

Performance of rapid test kits to assess household coverage of iodized salt. *Public Mealth Nutrition* 19 (15): 2712-2724.

Kakitahi J. and Olico-Okui 1991. Iodine deficiency disorders in Kisoro, Bundibugyo, Hoima and Kapchorwa districts. Preliminary Report to Ministry of Health, Kampala, Uganda.

Knowles, J. M., Garrett, G. S., Gorstein, J., Kupka, R., Situma, R., Yadav, K. and Aaron, G. J. 2017. Household coverage with adequately iodized salt varies greatly between countries and by residence type and socioeconomic status within countries: Results from 10 National coverage Surveys. *The Journal of Nutrition* 147 (5): 1004S-1014S. https://doi.org/10.3945/jn.116.242586

Lench, E.L., Getahun, D., Fikre, M.Z.K., Reta, F. and Bosha, T. 2017. Assessment of handling practices, utilization and concentration of iodine in Iodized salt at Wondo Genet Town, Southern Ethiopia: A cross sectional Study. *World Journal of Innovative Research* 3 (5): 262507.

Olico-Okui 2005. Assessment of the success of Uganda's USI in the control of IDD after 10 years. Makerere University Institute of Public Health. Kampala.

Owarwo, V.M. 1991. Iodine deficiency disorders in Masindi District. Preliminary Report. Ministry of Health, Kampala, Uganda.

Rohner, F., Zimmermann, M., Jooste, P., Pandav, C., Caldwell, K., Raghavan, R. and Raiten, D.J. 2014. Biomarkers of nutrition for development—iodine review. *The Journal of Nutrition* 144 (8): 1322S-1342S.

Statistics Department [Uganda] and Macro International Inc. 1996. Uganda Demographic and Health Survey, 1995. Calverton, Maryland: Statistics Department [Uganda] and Macro International Inc.

Uganda Bureau of Statistics and Inner City Fund. 2018. Uganda Demographic and Health Survey 2016. Kampala, Uganda and Rockville, Maryland, USA: UBOS and ICF.

Uganda Bureau of Statistics and Macro International Inc.2007. Uganda Demographic and Health Survey2006. Calverton, Maryland, USA: UBOS and Macro International Inc.

Uganda Bureau of Statistics and ORC Macro. 2001. Uganda Demographic and Health Survey 2000-2001.Calverton, Maryland, USA: UBOS and ORC Macro.

United Nations Children's Fund. 2019. Iodine. [Online] (Available from: https://data.unicef.org/topic/nutrition/iodine/. [Accessed July 26, 2021].

World Health Organization. 2007. International Council for the control of the Iodine Deficiency Disorders/United Nations Children's Fund (WHO/ICCIDD/UNICEF). Assessment of the iodine deficiency disorders and monitoring their elimination. Geneva: World Health Organization.

Zimmermann, M.B. and Andersson, M. 2021. Global Endocrinology: Global perspectives in endocrinology: coverage of iodized salt programs and iodine status in 2020. *European Journal of Endocrinology* 185 (1): R13-R21.