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Invited Commentary

Evaluating population salt reduction programmes worldwide: the risk of cutting corners!

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The question of how to assess salt intake in individuals and populations has been framed since the 1970s[1]. Salt intake is extremely variable between individuals as well as from day to day in the same person[2–4]. Therefore, even a single measurement of the daily amount of Na excreted in the urine (often regarded as the 'gold standard') is inadequate for assessing the salt consumption of an individual[3]. In a well-conducted physiological study, single 24 h urine collections at intakes ranging from 6 to 12 g salt/d were not suitable to detect a 3 g difference in individual daily salt intake[4]. Repeated measurements of 24 h urinary Na improve precision, suggesting multiple 24 h urine collections over time are necessary to assess a person's salt intake[4]. However, the interest in using easier alternative methods has led to a renewed curiosity into the validation of methods based primarily on estimating 24 h urinary Na excretion (hence salt intake) from spot urine samples. In an original systematic review including 1 380 130 participants from twenty studies, spot, timed and overnight urine samples showed greater intra-individual and inter-individual variability than 24 h urine collections. There was a wide range of correlation coefficients between 24 h urine Na and other measures of Na excretion[3]. Subsequently, numerous validation studies have been published, comparing 24 h urine collections *v.* estimates of daily Na excretion from spot urines extrapolated with the application of different formulas. From a variety of population analyses spot urines (irrespective of the formulas used to estimate daily consumption) lead to biased estimates of 24 h urinary Na excretion with overestimates at lower levels and underestimates at higher levels[5–9], making these measures not suitable to assess an individual's Na excretion (salt intake) in cross-sectional and prospective studies[10].

A different question has been put more recently as to whether we can estimate the average Na excretion for the population using spot urine samples, avoiding the burden of 24 h urinary collections in epidemiological settings[9,11]. This question has become repeatedly common given the need to assess average population salt consumption and to monitor and evaluate intervention programmes of population salt reduction over time within the UN resolution and WHO action plan to reduce global CVD by 2025[12].

The analysis of different South African population samples from various ethnic backgrounds (white, black, Indian), reported by Swanepoel *et al.* in this journal, is an important step forward[13]. It validates three formulas (Kawasaki, Tanaka and INTERSALT)[5,14–16] commonly used to estimate 24 h urinary Na excretion from spot urine samples against the direct measurements of Na excretion using a 24 h urine sample. The authors pooled data from three cross-sectional population studies in South Africa: the African-PREDICT study, including 470 black and white men and women aged 20–30 years; the Thusa-Bothle study, including 104 black women aged 35–65 years; and the KwaZulu-Natal study, including 107 Indian women aged 18–50 years. All three studies used common methodologies for collecting and analysing urine samples. Several measurements were considered: comparison of mean population Na excretions (estimated and measured); Bland–Altman plots[17] to calculate the bias in the spot estimate *v.* the 'gold standard' (24 h urinary excretion); proportional bias by linear regression of the difference in estimates *v.* the mean; interclass correlation coefficients between estimated and measured Na; and sensitivity and specificity of estimated Na excretion to correctly classify the mean population Na excretion below the WHO's recommended target of 2000 mg Na/d (5 g salt/d).

The search for validity in the framework of the global action plan is not so much to simply estimate the average population mean[9], or the proportion of the population with a salt intake 'above' a specific threshold[11], since the majority of populations globally are above that threshold[18]. The validations of two alternative measures should be able to: (i) estimate the absolute difference in salt consumption between two time points (measuring the effectiveness of a population programme of salt reduction); and (ii) estimate the proportion of the population 'below' a threshold of 5 g salt/d.

Crude direct comparisons between population means by Swanepoel *et al.* indicated that the Kawasaki and Tanaka formulas overestimate urinary Na excretion compared with 24 h urinary Na, whereas the INTERSALT formula – in a couple of cases – underestimates it. However, the degree of bias obtained from the Bland–Altman plots and the proportional bias measured indicate that all three formulas fall short of an ideal scenario. Both the Kawasaki and the Tanaka

formulas introduce a large negative bias (2242 and 837 mg Na, or 5·6 and 2·1 g salt, respectively) while the INTERSALT formula introduces a positive bias (161 mg Na or 0·4 g salt).

Furthermore, the proportional bias is the highest with the INTERSALT formula. As expected, interclass correlation coefficients are very low (the highest being 0·29 in white participants using the INTERSALT formula), even considering that the spot samples were not 'independent' of the 24 h samples. The important implication of these sets of results for policy is that all these formulas introduce a bias leading to a high degree of inaccuracy in the baseline estimation of population salt consumption, and, more importantly, do not enable them to detect small changes in population salt consumption over time ensuing from a salt reduction programme. For instance, the use of the Kawasaki or Tanaka formula would not have been able to detect the 1·4 g change in daily salt consumption in the 8-year UK national salt reduction programme, and a population change of 0·4 g – still an important change – could also be missed by the INTERSALT formula. The effectiveness of the population intervention would therefore be missed, with crucial implications for further political and industrial support to sustained salt reduction programmes and public health policies towards the ambitious, and yet achievable, WHO global target.

Swanepoel *et al.*'s analysis indicates that the sensitivity of all three formulas is high. This is not a very useful measure in the context of the evaluation of population salt reduction programmes. All countries in the world eat far more than the 5 g salt/d set by the WHO as target, and, even with successful short-term reductions, the proportion of those eating less than 5 g/d could still be very low despite successful reduction of mean levels. Specificity, on the other hand, is paramount. The specificity of all three formulas is <10 %, i.e. they are all unable to detect an increase in the proportion below the threshold. In other words, none of the formulas would be suitable to evaluate a population salt reduction programme accurately, even considering the single objective of measuring the proportion achieving target thresholds, with immediate risk to the continuation of the programme.

In conclusion, Swanepoel *et al.*'s analysis, while confirming the presence of biases and shortcomings in the use of spot urines to estimate population salt intake when compared with 24 h urine samples, is the first to acknowledge and discuss the important features required by a validation study to be able to inform public health recommendations for an effective evaluation and monitoring of long-term population salt reduction programmes. Spot urines are no substitute for 24 h urine collections in monitoring population salt reduction.

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