

Systematic review of studies comparing 24-hour and spot urine collections for estimating population salt intake

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ABSTRACT

Objective. To examine the usefulness of urine sodium (Na) excretion in spot or timed urine samples to estimate population dietary Na intake relative to the gold standard of 24-hour (h) urinary Na. **Methods.** An electronic literature search was conducted of MEDLINE (from 1950) and EMBASE (from 1980) as well as the Cochrane Library using the terms “sodium,” “salt,” and “urine.” Full publications of studies that examined 30 or more healthy human subjects with both urinary Na excretion in 24-h urine and one alternative method (spot, overnight, timed) were examined.

Results. The review included 1 380 130 participants in 20 studies. The main statistical method for comparing 24-h urine collections with alternative methods was the use of a correlation coefficient. Spot, timed, and overnight urine samples were subject to greater intra-individual and interindividual variability than 24-h urine collections. There was a wide range of correlation coefficients between 24-h urine Na and other methods. Some values were high, suggesting usefulness (up to $r = 0.94$), while some were low (down to $r = 0.17$), suggesting a lack of usefulness. The best alternative to collecting 24-h urine (overnight, timed, or spot) was not clear, nor was the biological basis for the variability between 24-h and alternative methods.

Conclusions. There is great interest in replacing 24-h urine Na with easier methods to assess dietary Na. However, whether alternative methods are reliable remains uncertain. More research, including the use of an appropriate study design and statistical testing, is required to determine the usefulness of alternative methods.

Key words

Sodium chloride, dietary; urine specimen collection; population.

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In steady-state conditions, the kidneys handle most of the sodium (Na) consumed in a day. The majority (up to 95%) is excreted in the urine within 24 hours (h). The remainder is excreted through

sweat, saliva, and gastrointestinal secretions. The daily renal excretion rate of Na is not constant throughout the 24 h; it depends on Na consumption patterns, such as time of day, an individual's posture, and neurohormonal influences.

A 24-h urine collection is the gold standard for assessing salt intake

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through urinary Na excretion in individuals and in populations (1). However, it is often deemed inconvenient for repeated use in large population studies. There are concerns that a high participation burden, a lack of completeness, and a high cost will affect the response rate and the practicality of using the test. Alternative methods, such as spot and timed urine samples, have been derived in an attempt to overcome this concern.

Assessing a population's salt intake and its changes over time underpins salt reduction policies and represents a major pillar of such programs globally (2–5). Yet, for many countries salt intake is not known.

Several questions need answering. Can average population salt intake be assessed with methods other than 24-h urine collections? Can daily intake be predicted from spot urine samples? Can daily intake be estimated from spot urine samples? Is validation for groups the same as that for individuals? Can methods other than 24-h urine Na be used for reliable monitoring of population changes? Are these methods valid in different population subgroups according to gender, age, and ethnicity?

The aim of this study was to systematically review all studies comparing 24-h urine collections with alternative methods (spot, overnight, daily, timed) to assess salt intake in adults and children.

METHODS

Literature search

A search strategy was developed to identify studies that reported the association between Na excretions obtained with 24-h urine collections compared with spot urine samples. The electronic databases MEDLINE (from 1950 to April, week 4, 2010) and EMBASE (from 1980 to May, week 1, 2010) as well as the Cochrane Library were searched using the terms “sodium [dietary, chloride, intake, excretion],” “salt [intake],” and “urine [timed, spot, random, 24-h].” Reference lists of original and review articles were examined to search for more studies. Only full-length articles were considered. English language restriction was applied. Only studies on humans were included.

Inclusion and exclusion criteria

Studies had to fulfil the following criteria: full paper, human study, population study or those in large groups ($n \geq 30$), availability of 24-h urine and urine collected by an alternative method (spot, overnight, timed), and availability of urinary analytes. Studies were excluded if: not in English, in abstract form, sample size < 30 , and done in special patient groups (e.g., renal or heart failure, congestive heart disease, diabetes, or patient groups on medication). If multiple published reports from the same study were available, only the one with the most detailed information for exposure and outcome was included.

Data extraction

Three investigators (C.J., L.S., and C.P.) extracted data independently and differences were resolved by discussion and consensus. Relevant data included the first author's surname, year of publication, country of origin of population studied, population type, sample size, age of population, duration of study, description of urine sampling, mean Na for 24-h and for alternative samples,

and outcome measures (correlations, ratios).

RESULTS

Characteristics of studies

Forty-three papers met the inclusion criteria. Of them 23 were excluded because of lack of data and 20 were suitable for final review: 16 in adults (6–21) and 4 in children (22–25) (Figure 1). When results were reported separately for independent groups, they were entered into the tabulation as separate studies (9, 13, 18, 19, 22). Overall, the review included 1 380 130 participants from 7 countries (5 from the United States of America, 6 from Japan, 3 from China, 2 from Brazil, and 1 each from France, Croatia, and the Netherlands). Fourteen studies recruited both men and women; 2 studies recruited only women. Four studies in five samples were carried out on children and adolescents.

Studies comparing 24-h with overnight samples in adults

Table 1 summarizes studies in adults. Nine studies tested the correlation

FIGURE 1. Flowchart of systematic review

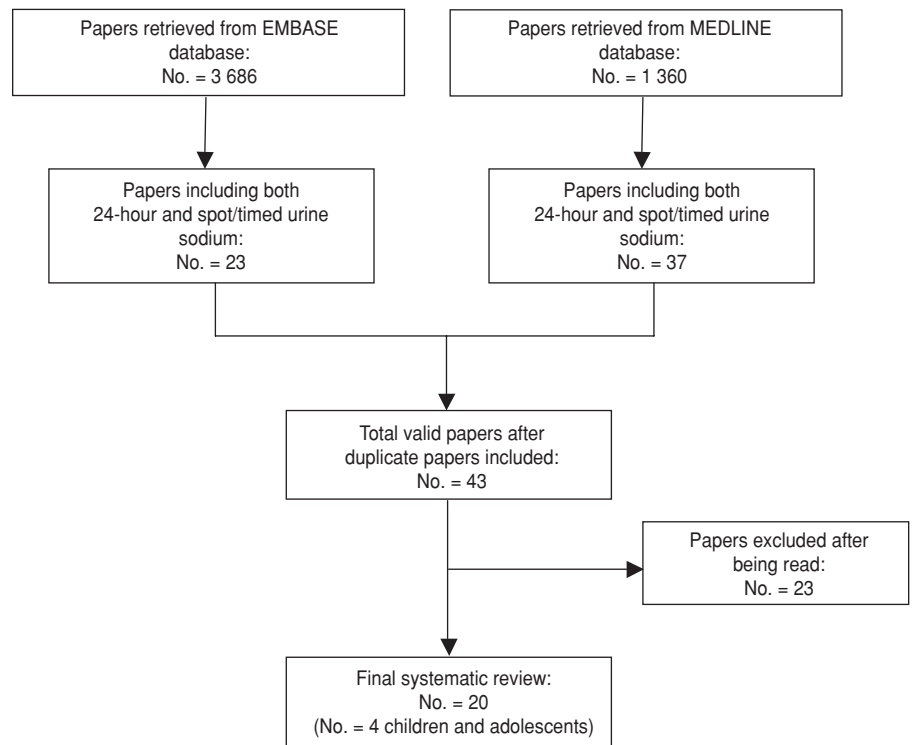


TABLE 1. Systematic review of studies in adults

Author, year (ref.)	Country	Population	Sample size	Age, years	Duration	Urine samples	Mean Na amount, mmol		Ind. samples	Correlation	Notes
							24 h	Spot			
Liu et al. 1979 (6)	United States of America	Business and administrative volunteers	116 men	30–44	4 days	24 h versus daytime (d) versus overnight (ov)	165–183	116–138 d 45–57 ov	No	0.722 versus ov	Flame photometry. Conditional probability of 24-h Na in 5th quintile to 3rd tertile ranges from 0.58 to 0.77, given night Na in 5th quintile. If overnight used, at least 1-week collection.
Yamori et al. 1982 (7)	Japan	Healthy volunteers	Farming and fishing villages 39 men, 44 women	30–50	1 day	24 h versus d versus evening (e) versus ov versus spot	202 farming 198 fishing	n/a	No	Na/Cr 0.717 d 0.559 e 0.419 ov 0.463 spot	Flame photometry. Daytime best substitute.
Luff et al. 1982 (8)	United States of America	University students and employees	12 white men, 10 white women, 14 black men, 7 black women	19–54	15 consecutive days	24 h versus 16 h diurnal versus 8 h nocturnal for 10 days	139	28 (night)	No	0.22	Nocturnal urine samples are not useful to estimate mean Na intake.
Kawasaki et al. 1982 (9)	Japan	Healthy volunteers	91 men, 151 women	20–63	3 days	24 h versus spot (within 4 h after first morning void)	218	n/a	No	0.467 versus spot, 0.624 versus 3-day average	Flame photometry with lithium as internal standard.
Wolf et al. 1984 (10)	France	Healthy volunteers	Supine (s): 61 men, 30 women Upright (u): 30 men, 30 women	20–68	n/a	24 h versus spot	6.15 ^a s 5.91 ^a u	13.3 ^b s 7.85 ^b u	Yes	n/a	Flame photometry. Spot urine overestimates urine Na excretion rate.
Liu et al. 1986 (11)	China	Healthy doctors and technicians	49	30–50	6 samples over 3 months	24 h versus d versus ov for 6 days	231 d 262 ov	94 110	No	0.94	Flame photometry. Overnight urine sample could be used but 6 specimens needed.
Liu et al. 1987 (12)	China	Normotensive health professionals	50 men	27–50	10 days	24 h versus d (12 h) versus nighttime (n) (12 h) 6 days	235 (d) 260 (n)	122–142 d 109–122 n	No	0.92	Flame photometry. Conditional probability of 24-h Na in 5th quintile to 3rd tertile ranges from 0.774 to 0.950, given night Na in 5th quintile.
Kawasaki et al. 1993 (13)	Japan	Healthy free-living individuals	Group 1: 91 men and women Group 2: 15 men and women	20–79	Group 1: 1 day Group 2: 3 days	24 h versus spot	233 men, 185 women	n/a	Yes	0.728 0.531 (external group)	Flame photometry.
He et al. 1993 (14)	China	Normotensive men	30 farmers, 33 urban dwellers	19–55	3 days	24 h versus ov (8 h)	147 day 1 155 day 2 165 day 3	38 in 8 h 41 in 8 h 43 in 8 h	No	0.843	Flame photometry. Overnight collections underestimated 24-h Na by 1.99 mmol/h (~ 48 mmol/24 h).

(continued)

TABLE 1. (Continued)

Author, year (ref.)	Country	Population	Sample size	Age, years	Duration	Urine samples	Mean Na amount, mmol		Ind. samples	Correlation	Notes
							24 h	Spot			
Costa et al. 1994 (15)	Brazil	Healthy individuals	611	20–74	Single test	24 h versus spot	220	n/a	Yes	0.28	Flame photometry. Spot urine overestimates Na excretion.
Pan et al. 1994 (16)	China	Research staff	21 men, 19 women	24	1 month	24 h versus half-day (hd) versus ov	151	69 hd 31 ov	No	0.83 versus same day 0.41 versus adjacent day 0.41 versus 1 month apart using hd urine 0.60 versus same day 0.28 versus adjacent day 0.28 versus 1 month apart using ov urine	Ion-selective electrode method.
Tanaka et al. 2002 (17)	Japan	Group 1: INTERSALT participants, Group 2: manual workers	295 men, 296 women	20–59	n/a	24 h versus spot	187	179 (estimated)	Yes	0.54	Emission flame photometry. Estimated means lost accuracy on lower salt intakes. Spot urines underestimated true excretion. Needs population-specific validation with age, weight, height, and 24-h sample.
Kamata and Tochikubo 2002 (18)	Japan	Healthy individuals	Study 1: 126 men, 225 women	38 50	n/a	24 h versus predicted by Cr and lean mass	n/a	n/a	No	0.73 0.78	Automated IEM. Population specific, needs validation. Overnight urine underestimates true value with gender differences and risk of bias.
Kamata and Tochikubo 2002 (18)	Japan	Healthy individuals	Study 2: 71 men, 78 women	35 49	n/a	24 h versus ov with sampling pipe	n/a	n/a	No	0.59 0.67	Automated IEM. Population-specific, needs validation. Overnight urine underestimates true value with gender differences and risk of bias.
Yamasue et al. 2006 (19)	Japan	Healthy adults	Study 1: 62 men, 188 women	54	n/a	24 h versus ov	n/a	n/a	No	n/a	Comparing two methods
Yamasue et al. 2006 (19)	Japan	Healthy adults	Study 2: 70 men, 154 women	53	21–66 days	24 h with IEM versus ov with NSM	n/a	n/a	No	0.72	Comparing two methods
Ilich et al. 2009 (20)	Croatia	Healthy participants	143 women	30–79	n/a	24 h versus fasting spot	16.6 ^b	12.9 ^b	Yes	0.452	Flame atomic absorption/emission spectrometry.
Mann and Gerber 2010 (21)	United States of America	Unselected volunteers	81	21–82	n/a	24 h versus spot, AM, and PM	181 spot 188 AM 164 PM	160 176 158	No	0.17 spot 0.31 AM 0.86 PM	Treated individuals.

Notes: Ind.: independent, Na: sodium, Cr: creatinine, n/a: not available, IEM: ion-electrode method, NSM: new salt monitor, h: hour, d: daytime, ov: overnight, n: nighttime.

^a Na (mmol/h).

^b Na/Cr ratio (mmol/h).

between 24-h and overnight urinary Na (6–8, 11, 12, 14, 16, 18, 19). Ten studies used flame photometry to analyze Na concentrations (6, 7, 9–15, 17), one (16) used an ion-selective electrode method, and one (19) used a new salt monitor. One study analyzed the correlation coefficient of the true mean 24-h urine Na and the true mean overnight urine Na in order to eliminate the influence of intra-individual variation (6). It suggested that at least a week of overnight samples would be required to reduce the intra-individual variation.

Luft et al. studied the Na intake by placing participants on a fixed diet and monitoring their urinary output (8). They found that the mean Na intake showed a greater correlation with the 24-h ($r = 0.75$) than with the overnight ($r = 0.55$) Na. They recognized that daily variation in salt intake is a limitation and concluded that overnight urine collections do not appear to be a promising way to estimate mean Na intake.

Another study found a correlation of 0.94 between the true mean 24-h and overnight Na excretion (11). The urine samples were not collected on consecutive days. Another study collected six 24-h urine samples gathered over 10 days and reported a high correlation between the true mean overnight and 24-h urine Na ($r = 0.92$) (12). There was a greater degree of intra- and inter-individual variation with the overnight urine Na collections than with the 24-h excretions and thus a greater number of samples would be needed to accurately measure Na intake in populations.

He et al. found a correlation coefficient of 0.843 between the 24-h and overnight true mean values when pooling data from rural and urban residents (14). Despite a strong correlation, double the amount of samples would be needed to limit the diminution of correlation coefficient to < 5%. The strength of this study was the inclusion of rural population samples in contrast to previous studies of predominantly urban populations with a high salt intake.

In relation to time of day, one study found that the correlations between 24-h urinary electrolytes and half-day (12-h duration) urine contents were better than correlations with overnight (8-h duration) samples (16). This finding was probably due to the longer time period involved with the half-day collections. This study did not find a strong corre-

lation between the 24-h and overnight urine Na and cautioned about using a partial sample as a substitute for 24-h urinary Na analysis.

A few studies piloted the use of purpose-built devices to facilitate partial urine collections. Kamata and Tochikubo devised a urine-sampling pipe with a two-way stopcock that could trap overnight urine proportionally to estimate the volume of overnight urine and to estimate 24-h urine Na (18). They accounted for the lean body mass of individuals to estimate the 24-h urine Na levels. Using an electrical device to monitor daily salt intake at home, another study found a significant correlation between 24-h urine Na excretion and overnight values (19). The correlation between 24-h urine Na with an ion-electrode method and the measured value with a new salt monitor using overnight urine was significant ($r = 0.72$). The self-monitoring method suggested overnight sampling as an adequate substitute for 24-h urine collection.

Studies comparing 24-h with spot sampling in adults

Eight studies included in the review compared 24-h urine Na contents and single spot urine Na (7, 9, 10, 13, 15, 17, 20, 21).

Kawasaki et al. showed that in 242 participants a single 24-h urine specimen did not represent the individual average of daily Na excretions (9). The correlation coefficient between spot and 24-h urine was 0.467. When they averaged 3 daily collections from 117 participants, the correlation coefficient was 0.624. They also compared urine samples from 59 persons with an intra-individual standard deviation of a spot urine specimen for excretion of creatinine within 20%. The correlation coefficient was 0.725.

Wolf et al. looked at using a spot urine sample instead of the usual 24-h sample to measure urine Na (10). There was an overestimation of both the excretion rate and the Na/creatinine ratio when the spot urine was compared with the 24-h sample. The spot sample, carried out in the morning after overnight fasting, was closely related to the 24-h sample.

Kawasaki et al. found that spot samples of second morning voided urine, collected over 3 days, give a more reliable and accurate estimation of 24-h urine Na than a 1-day collection (13).

They found a highly significant correlation ($r = 0.774$). They also found that the correlation was stronger when they used morning spot samples rather than night samples.

Costa et al. analyzed the relationship between systolic pressure and Na excretion at different levels of diastolic pressure (15). They used a single casual spot sample instead of 24-h urine to estimate Na excretion. They found that spot samples showed significantly higher estimates of Na excretion than 24-h collections, with a weak positive correlation coefficient ($r = 0.28$). They concluded that this weak but significant correlation suggests that an even larger sample of spot urine collections would be needed compared with 24-h urine samples to detect an association between blood pressure and Na excretion.

Tanaka et al. found that the correlation between the 24-h and the spot urine Na was 0.65 (17). They concluded that the method would be a convenient and accurate way to estimate population Na intake. They discussed that individual monitoring should still use 24-h samples, but spot samples are good alternatives to monitor and evaluate population mean Na intake.

In another study, the ratio between 24-h and spot samples was 2.0 (20). The study also reported a correlation between spot and 24-h urine Na of 0.45. This study concluded that spot urine could be used instead of “tedious and impractical 24-h urine collection.” The study noted that spot sampling is not sufficient in all cases but is a reliable alternative to 24-h sampling.

More recently, Mann and Gerber compared three spot samples—random, AM, and PM—with a 24-h sample (21). When Na/creatinine ratios were adjusted for 24-h creatinine excretion, all correlations were strengthened. The correlations between the 24-h Na excretions were 0.17, 0.31, and 0.86 for random, AM, and PM samples, respectively. The value for the random sample was not significantly correlated and therefore would not be a good alternative to 24-h urine Na collections. However, a spot sample collected in the late afternoon or early evening before dinner, adjusted for 24-h creatinine excretion, accurately predicts 24-h Na excretion. They concluded that the use of spot urine is convenient and cost-effective in assessing Na excretion in clinical practice and epidemiologic studies.

All but one study comparing spot and 24-h urine collections advocated using the spot sampling method (9). There was a significant consensus that using spot urine samples would require a greater number of collections, but it would still be more convenient and feasible for general populations that require monitoring.

Studies comparing 24-h with multiple other sampling techniques in adults

Yamori et al. looked at 24-h urine samples split in three parts and found that the highest correlation of Na in the urine samples occurred in the daytime voided urine and the second highest correlation was in the overnight voided urine (7). The correlation was low. Despite the higher correlation between daytime voided urine and 24-h collection, practicality favors evening and overnight collections as most individuals can do them at home. They suggest the use of partial urine samples to analyze Na intake and

even the use of single spot urine samples for large population surveys.

Studies comparing 24-h with other sampling techniques in children

The studies in children and adolescents are summarized in Table 2. The studies included ages 3–18 years and compared overnight urine samples with 24-h samples. In all studies, multiple collections were used [from a minimum of 2 (23) to a maximum of 7 (22, 25) days]. Most studies used correlation coefficients to assess concordance, reliability, and reproducibility, with values varying from 0.62 (24) to 0.95 (25).

DISCUSSION

This study is the first systematic review of studies comparing simple measures of urine Na excretion with 24-h urine Na excretion. The studies are heterogeneous in objectives, protocols,

types of urine collections, number of repeated measures, populations studied, measures taken for validation, and analytic approaches. This study does not, therefore, provide a uniform pool of data to assess the evidence with consistency, as reflected in the contrasting conclusions that have been reached over the years in favor of and against the suitability of alternative methods for assessing urine Na excretion (a proxy for salt intake) instead of 24-h urine Na excretion.

Advantages and disadvantages

There are advantages and disadvantages in the different options (1, 2). The gold standard for assessing daily salt intake is 24-h urine collection. It captures > 90% of the Na ingested around the time of collection. When applied to population samples, however, it may pose a high burden on participants, with a resultant risk of low participation rates.

TABLE 2. Systematic review of studies in children and adolescents

Author, year (ref.)	Country	Population	Sample size	Age (years)	Urine Samples	Duration	Mean Na amount, mmol		Independent sample	Correlation	Notes
							24 h	Spot			
Liu et al. 1979 (6)	United States of America	Grades 6–8	31 boys	11–14	24 h versus overnight	7 days	123	49	No	0.73	Automated methods. Conditional probability of 24 h in 5th quintile to 3rd tertile ranges from 0.59 to 0.78, given nighttime Na in 5th quintile.
Liu et al. 1979 (22)	United States of America	Grades 6–8	42 girls	11–14	24 h versus overnight	7 days	150	69	No	0.73	Automated methods. Conditional probability of 24 h in 5th quintile to 3rd tertile ranges from 0.59 to 0.78, given nighttime Na in 5th quintile.
Micheli and Rosa 2003 (23)	Brazil	Children and teens	31	6–17	24 h versus overnight versus food record	2 days	146, 162	137	No	0.71	Ion selective electrode method. 24-h urine still most reliable way to determine urine Na.
Luft et al. 1984 (24)	United States of America	Twins	52 boys, 43 girls	3–18	24 h versus overnight	5 days over 1 month	115	37 (night)	No	0.62	Flame photometry.
Knuiman et al. 1988 (25)	Netherlands	Boys	28	8–9	24 h versus overnight	7 days	101	34 (night)	No	0.95	Flame atomic absorption spectrometry. Overnight may replace 24 h in young boys, but more overnight than 24-h specimens are required to achieve similar precision.

Note: Na: sodium.

The inaccuracy of completeness (both under- and overcollections) is also a concern. The biochemical method of administering para-aminobenzoic acid for 3 days before urine collection would overcome this problem (26–28). The body does not metabolize para-aminobenzoic acid and, once absorbed in the bloodstream, it is flushed through the kidneys with excretion being ~ 100% of the ingested load. A direct measurement of para-aminobenzoic acid in the urine would allow a direct measure of completeness. However, this method does not provide a feasible alternative for population monitoring, especially in low- and middle-income countries. It reduces the response rate, as participants have to plan in advance and take three pills on the days before collection. Nonresponders (hence defaulters) will be identified only after para-aminobenzoic acid has been measured (and undetected) in the urine, with resource implications in terms of additional laboratory costs, pill costs, and unnecessary screenings.

A less precise but more feasible alternative is to measure urine creatinine excretion, which is constant within an individual at rest and depends mainly on lean body mass and age.

One advantage of 24-h urine collection is that it can be used at the same time for monitoring total iodine intake and therefore complements population programs of universal salt iodization for the prevention of iodine deficiency (29).

Feasibility and usefulness

For more than four decades, 24-h urine collections have been used in population studies. The most compelling evidence of feasibility and usefulness comes from the INTERSALT study, an international study of the relationships between salt intake and blood pressure (30). INTERSALT was carried out in 52 population samples on all continents and included samples from remote populations in the Amazon jungle, Africa, Australasia, and rural China. Practicalities were addressed with local training that allowed the quality of 24-h urine collections to be preserved.

In addition, community-based studies in rural Africa have been able to perform 24-h urine collections with training of health care assistants at low cost (31–34).

Alternative methods

Several methods of partial urine collections (spot, timed, daytime, evening, overnight) are alternatives to 24-h urine collection. They are less onerous for participants, can allow faster screening time, and require less training for staff. They are highly variable at the individual level but can give reasonable estimates of group means, an aspect that makes them of interest for long-term monitoring and population surveillance. These methods are highly dependent on hydration, duration and volume of collection, and high proportional residual bladder volume. They are expressed as Na concentration per liter (rather than total daily excretion) and are converted to estimated 24-h Na excretion. No means is available to establish the precision, validity, and reliability of these conversions.

The method of Tanaka et al. (17), for example, is population specific; requires internal calibration with age, weight, and creatinine; overestimates low intakes and underestimates high intakes; and has very low specificity for identifying lower salt intake (35). Moreover, the relationship between urine concentrations and total excretions does not give information on population distributions (36).

Spot urine samples are currently used to monitor iodine status in global salt iodization programs around the world, mainly in children and in women of childbearing age (29). These methods are less desirable for the initiation of monitoring programs of population salt reduction because they cannot provide an absolute measure of salt intake at baseline. However, they may prove useful in repeated assessments over the course of the programs to assess relative changes from a known baseline (1).

Implications for future research and policy

The assessment of population salt intake underpins the implementation of policies to reduce salt intake (2, 5). This result can be achieved by measuring and estimating average population levels and average changes over time in the population as a whole and in subgroups as well as in population distributions (36). This objective differs from the need

to measure an individual's salt intake. This systematic review indicates that most studies aimed at answering the latter question, and almost every study relied on correlation analyses and the strength of the correlation coefficients to draw conclusions. Most studies compared 24-h urine data with data derived from partial collections that were part of the 24-h collection (i.e., dependent collections) rather than independent of it. This important point was recently highlighted by Mann and Gerber (21). The appropriate validation test would be between a 24-h sample and an alternative sample independent of the 24-h collection to avoid spurious intercorrelations (as it would be when reassessing salt intake in different population samples over time).

Correlation may not be the best measure to assess the question in the current context of monitoring and evaluating public health programs of population salt reduction in which average values are estimated and followed up over time. Very few studies have used this approach. In Scotland, for example, in the 2006 Health Survey 24-h urine Na was weakly correlated with a urine Na/creatinine ratio obtained from spot urine collections (37). There was poor reproducibility of three consecutive spot urines (worse in women) and poor discrimination among groups in the second, third, and fourth quintiles of 24-h urine Na distribution.

A recent study reported the results of a comprehensive validation analysis of 24-h compared with timed and independent urine collections in a British multiethnic population of men and women and independently validated in another population sample of Italian men (35). The study compared different methods to estimate 24-h Na output from timed collections and used not only correlations but Bland–Altman plots, prediction of quintile position, and sensitivity and specificity of detecting a reduction of Na excretion below 100 mmol/day using receiver operating characteristic areas under the curve. The study shows consistent bias, moderate sensitivity, and low specificity using timed urine samples.

Finally, a national survey of salt intake in Ireland used spot urine collections to estimate population levels of salt intake and 24-h collections in an independent subsample of the population (38).

The average values were close to each other (10.3 versus 10.4 g of salt/day in men and 7.4 versus 7.4 g of salt/day in women). The study did not break down data by age or by quintile of salt intake to determine whether biases across ages and levels of intake were present.

Conclusion

Although inconclusive in providing an answer to modify current recommendations, this systematic review highlights the inadequacies of current evidence and the need for validation studies pertinent to the context of population monitoring of salt intake and of evaluation and surveillance of salt reduction programs. It suggests that 24-h urine collections in small surveys are viable and reliable. In the absence of more definitive evidence, the authors endorse the recommendations of the Pan American Health Organization–World Health Organization Regional Expert Group in that “until more studies are carried out to assess

simpler but reliable methods of urine collection for the purpose of estimating daily excretions [of sodium], 24 hour urine collections are recommended” (1).

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RESUMEN

Revisión sistemática de estudios comparativos entre recolección de muestras de orina de 24 horas y puntual para calcular el consumo de sal en la población

Objetivo. Analizar la utilidad de la medición de la excreción urinaria de sodio a partir de la recolección puntual o cronometrada de muestras de orina para calcular la ingesta de sodio alimentario en la población, en relación con la prueba de referencia que mide la excreción de sodio en orina de 24 horas.

Métodos. Se realizó una búsqueda de bibliografía electrónica en MEDLINE (desde 1950) y EMBASE (desde 1980), así como en la Biblioteca Cochrane, empleando los términos “sodium”, “salt” y “urine” (sodio, sal y orina). Se examinaron las publicaciones completas de los estudios que incluían 30 o más sujetos humanos sanos en los que se hubiera determinado la excreción de sodio mediante la recolección de orina de 24 horas o un método alternativo (recolección puntual, de toda la noche, cronometrada).

Resultados. La revisión incluyó a 1 380 130 participantes de 20 estudios. El principal método estadístico adoptado para comparar las recolecciones de orina de 24 horas con los métodos alternativos fue el uso de un coeficiente de correlación (r). Las muestras de orina recolectadas de forma puntual, cronometrada y de toda la noche estaban sujetas a mayor variabilidad intra e interindividual que las recolecciones de orina de 24 horas. Se obtuvo una amplia gama de coeficientes de correlación entre las determinaciones de sodio en orina de 24 horas y mediante los otros métodos. Algunos valores fueron elevados, lo que indica su utilidad (r de hasta 0,94), mientras que otros fueron bajos (r por debajo de 0,17), lo que indica su falta de utilidad. La mejor alternativa a la obtención de orina de 24 horas (de toda la noche, cronometrada, o puntual) no resultó evidente, ni tampoco la base biológica de la variabilidad entre el método de 24 horas y los alternativos.

Conclusiones. Hay mucho interés en remplazar la determinación de sodio en orina de 24 horas por otros métodos más fáciles de evaluación del sodio alimentario. Sin embargo, sigue habiendo incertidumbre sobre la fiabilidad de los métodos alternativos. Es preciso ampliar la investigación, incluido el uso de un diseño de estudio y pruebas estadísticas apropiados, para determinar la utilidad de los métodos alternativos.

Palabras clave

Cloruro de sodio dietético; toma de muestras de orina; población.