Appendix L. Anthropometry Quality Control

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L.1. Background

Reliable data on anthropometric measurements in children are a prerequisite for the accurate assessment of their nutritional status.

L.1.1 Ethical approval

Ethical approval for the main DNSIYC survey was granted by Cambridgeshire 4 Research Ethics Committee (REC) on 18 January 2010. Ethical approval for DNSIYC QC studies was granted by Cambridgeshire 4 REC as Amendment 1 to the main survey on 5 March 2010.

L.2. Aims

L.2.1 To measure the intra-observer and inter-observer accuracy of NatCen interviewers to measure length, weight and occipito-frontal head circumference on infants in the Diet and Nutrition Survey of Infants and Young Children (DNSIYC) in the home

L.2.2 To measure the intra-observer and inter-observer accuracy of nurses at 23 clinical sites and on two mobile units to measure infant triceps and subscapular skinfold thickness in DNSIYC

L.3. Methods

Interviewers

Natcen interviewers working on DNSIYC were given basic training and certified in infant length, weight and head circumference measurements before the start of the survey. Refer to Appendix A for DNSIYC methods and Appendix H for protocols.

A quality control (QC) session was organised mid-way between Wave 1 and 2 of the mainstage of DNSIYC to measure the accuracy of the measurements taken by interviewers involved in the survey. The method used was a test-retest design.

Clinics and mobile units

Clinic nurses and mobile unit phlebotomists/research assistants were trained in taking infant skinfold thickness measurements before the DNSIYC fieldwork began.

Clinics were asked to undertake quality control measurements half way through fieldwork. All nurses at each clinic were asked to take measurements on the same two to three children unless there were more than four nurses at

the site, then the nurses were split into pairs and each pair was asked to take measurements on the same two to three children. This was to avoid infants being measured an excessive number of times.

Both interviewer and clinic training sessions were overseen by two research nurse supervisors, employed on DNSIYC, from the Department of Paediatrics at Addenbrookes hospital, and who each had around 10 years experience in taking infant anthropometric measurements.

Mobile unit phlebotomists/research assistants were accompanied by an experienced nurse supervisor for their QC sessions and both took measurements on the same two to three infants.

The resulting data were used to produce technical error of the mean measurements (TEMs). The TEM is the standard deviation of differences between repeated measures (Mueller and Martorell, 1988[1]). In practice, this means that 95% of repeat results will fall within ± 1.96 x TEM. In the test-retest study the differences between the closest two measurements were used to produce both the intra-interviewer (within) and inter-interviewer (between) TEMs for each measurement.

There are stages in the calculation of the TEM. Two main stages are as follows:

$$\text{Calculation of absolute TEM} = \frac{\sqrt{\sum di^2}}{2n}$$

Where:
$\sum d^2$ = summation of deviations raised to the second power
n = number of volunteers
i = the number of deviations

$$\text{Calculation of relative TEM} = \frac{\text{TEM}}{\text{VAV}} \times 100$$

Where:
TEM = Technical error of measurement expressed in %
VAV = Variable average value (sum of measurement averages divided by the total number of volunteers)

The lower the TEM obtained, the better the accuracy is to perform the measurement.

L.3.1. Recruitment of infants for interviewer QC

Nine infants, aged between 4 and 18 months were recruited along with their mothers from a list of HNR employees, from friends and families of HNR employees, or were infants who were involved in the DNSIYC Dress Rehearsal whose parents expressed an interest to be involved in any future infant studies. Participants were asked to arrive at one of two different times, 10am or 12.30pm at the Cherry Hinton Village Centre, in Cambridge, on 7 March 2011.

The infants were kept for a maximum of three hours to ensure the burden for infant and mother was kept to a minimum. Toys, music and interactive DVDs were available to keep the infants entertained and catering was provided.

L.3.1.1 Measurements

Infants were measured up to a maximum of three times for both supine length and head circumference.

Each of nine interviewers, were asked to undergo an unblinded test-retest reliability procedure This involved taking two head circumference and two length measurements on a minimum of two infants and a maximum of three infants, depending on how receptive the infants were. If the two measurements for head or length were not within 0.5cm of each other, then a third measurement was taken. The closest two measurements were recorded.

Head circumference was measured using a Child Growth Foundation disposable head circumference tape[2]. Infant length was measured using a Rollameter baby measure mat[3]. For full details of the infant measurement methods see Appendix O.

The resulting data were used to produce technical error of the mean measurements (TEMs).

L.3.2 Recruitment of infants for measurement in clinics and mobile units

Randomly selected mothers of DNSIYC Dress Rehearsal participants from Cambridge and surrounding areas were asked to participate in the QC exercise. If parents' authorisation was granted, the infant's head and length were both measured three times by a maximum of three nurses.

QC was carried out in a selection of six of the hospital based clinics, in Cambridge (a non-NHS clinic) and on the mobile unit. A mixture of clinics from across the UK that were experienced or not experienced in taking

skinfold thickness measurements before being trained in DNSIYC were selected.

Table L.A. Clinics selected for participation in QC

Clinic	Type	Experience level before DNSIYC
Edinburgh	NHS	Inexperienced
Glasgow	NHS	Inexperienced
Great Ormond Street Hospital, London	NHS	Inexperienced
Cambridge	Non-NHS	Inexperienced
Bradford	NHS	Experienced with infant skinfold thickness measurements
Manchester	NHS	Experienced with adult skinfold thickness measurements
Southampton	NHS	Experienced with infant skinfold thickness measurements

QC was carried out for all three mobile unit phlebotomists/research assistants as all were inexperienced in taking skinfold thickness measurements before DNSIYC and also because the environment (limited space) made it more difficult to take these measurements. This made it essential to ensure that the measurements were being carried out correctly by all those taking them in this environment.

L.3.2.2 Measurements

Skinfold thickness measurements were carried out on the child at the subscapular and triceps sites using the Holtain Tanner skinfold caliper[4]. For full details of the skinfold thickness methods and protocol see Appendix O and E.

Nurses at each site were asked to group into twos or threes and take three subscapular and three triceps skinfold thickness measurements on the same two or three children.

Mobile unit phlebotomists/research assistants and their accompanying nurse supervisor were asked to take three subscapular and three triceps skinfold thickness measurements on the same two or three children, the exact number depending on the number of clinic appointments booked for that day.

The resulting data were used to produce technical error of the mean measurements (TEMs).

L.4. Results

Table L.B. Maximum acceptable values for Relative TEM[5]

Type of analysis	Type of measurement	Beginner anthropometrist	Skilled anthropometrist
Intra-observer	Skinfolds	7.5%	5.0%
	Other measures	1.5%	1.0%
Inter-observer	Skinfolds	10%	7.5%
	Other measures	2.0%	1.5%

L.4.1. Interviewer results

A total of 25 measurements for head circumference and 26 measurements for length were taken by nine interviewers, on seven children. Two further infants became distressed when measurements were begun and so were withdrawn from the session.

Table L.C. Relative and absolute TEM for infant head and length measurements by NatCen interviewers

Type of analysis	Technical error of the mean	Head circumference	Length
Intra-observer	Absolute TEM (cm)	0.0	0.5
	Relative TEM	0.1%	0.6%
Inter-observer	Absolute TEM (cm)	0.3	0.9
	Relative TEM	0.6%	1.1%

The intra-observer TEMs for head (0.1%) and length (0.6%) were within the acceptable level for skilled anthropometrists. Similarly, the inter-observer TEMs for head (0.6%) and length (1.1%) were within the acceptable level for skilled anthropometrists.

L.4.2. Clinic and mobile unit results

A total of 50 subscapular measurements from 18 children and 54 triceps skinfold thickness measurements from 21 children were taken by 26 and 24 nurses respectively from clinics and mobile unit sites across the UK. The Glasgow clinic did not complete the QC due to timing of the QC session. In Wave 2 there were very few children who attended the Glasgow clinic and

when attempted, on two occasions, children became distressed and the session was abandoned.

Table L.D. Relative and absolute TEMs to the nearest decimal point for triceps and subscapular skinfold thickness measurements by clinics and mobile unit nurses

Type of analysis	Technical error of the mean	Triceps	Subscapular
Intra-observer	Absolute TEM (mm)	0.0	0.2
	Relative TEM	0.2%	2.4%
Inter- observer	Absolute TEM (mm)	0.1	0.1
	Relative TEM	1.3%	1.7%

The intra-observer TEMs for triceps (0.2%) and subscapular skinfolds (2.4%) were within the acceptable level for skilled anthropometrists. Similarly, the inter-observer TEMs for triceps (1.3%) and subscapular skinfolds (1.7%) were also within the acceptable level for skilled anthropometrists.

L.5. Discussion

The TEM is the statistic most commonly used to describe measurement error[6] and provides information to determine whether a set of anthropometric measurements are reliable. It is recognised that the robustness of our estimates of reliability of infant measurements is likely to be affected by the small sample numbers[7]. Ideally, one would like to assess the reliability repeatedly on large numbers throughout the survey period but, in practice, this is extremely difficult.

After training in head and length measurements for interviewers and skinfold thickness measurements for clinics and mobile units, TEM's were within published acceptable thresholds for these measurements[8,9]. For these reasons, the TEMs in DNSIYC indicate good reliability of growth measures.

Previous quality control assessments at the MRC Epidemiology Unit (not published) have shown inter-observer variations of 4-11% for triceps and 3-4% for subscapular measurements. While variation of <10% would be ideal, skinfold measurements are notoriously difficult, possibly more so in adults where variations of up to 15-20% are often reported.

As the absolute measurement decreases, it is likely that absolute measurement error also decreases. This may be one reason why the

absolute TEMs in DNSIYC infants are small, compared to data on adults[10], and suggests that these results should be compared to age specific TEMs. The DNSIYC TEMs for head circumference and skinfold thickness measurements are comparable with those reported by the WHO multicentre Growth Reference Study Group, 2006[11] for infants aged 0-1 years, and they are also within those reported in the Born in Bradford (BIB) study of 0-2 year olds[7].

L.6. Conclusion

The quality control studies in DNSIYC show that the head circumference and length measurements carried out by interviewers and skinfold thickness measurements conducted in clinics and mobile units are sufficiently reliable. The production and use of standardised training protocols, video-recorded training materials, and measurement protocols may have helped to standardise measurement techniques of interviewers, clinic nurses and mobile unit phlebotomists/research assistants.

References and endnotes

[1] WH Mueller, R Martorell. Reliability and accuracy of measurement. In: TG Lohman, AF Roche, R Martorell (Eds). Anthropometric Standardisation Reference Manual. Human Kinetics Books, Illinois, 1988 pp83-86

[2] http://www.childgrowthfoundation.org/ghd.htm 11 August 2010

[3] http://www.healthforallchildren.com/index.php/shop/category-list/Length+Measure 03 January 2012

[4] http://www.holtain.com/tw.php 11 August 2010

[5] Gore et al. In K Norton, T Olds editors. Antropometrica. Argentina: Biosystem, 2000

[6] WH Mueller, R Martorell. Reliability and accuracy of measurement. In: TG Lohman, AF Roche, R Martorell (Eds). Anthropometric Standardisation Reference Manual. Human Kinetics Books, Illinois, 1988 pp83-86

[7] J West, B Manchester, J Wright, DA Lawlor, D Waiblinger. Reliability of routine clinical measurements of neonatal circumference and research measurements of neonatal skinfold thicknesses: findings from the Born in Bradford study. 2011 Paediatric and Perinatal Epidemiology Vol 25, Issue 2, pp 164–171

[8] TA Perini, G Lameira de Oliveira, J dos Santos Ornellas and F Palha de Oliveira. Technical error of measurement in anthropometry. 2005 Rev Bras Med Esporte – Vol. 11, No. 1

[9] SJ Ulijaszek and DA Kerr. Anthropometric measurement error and the assessment of nutritional status. British Journal of Nutrition (1999), 82, 165–177

[10] W Johnson, N Camberon, P Dickson, S Emsley, P Raynor, C Seymour. J Wright. The reliability of routine anthropometric data collected by health workers: A cross-sectional study. 2009 International Journal of Nursing Studies 46, 310-316

[11] WHO Multicentre Growth Reference Study Group Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study. Acta Paediatrica 2006, 450, pp 38–46