

Wahakura Versus Bassinet for Safe Infant Sleep: A Randomized Trial

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abstract

OBJECTIVES: To compare an indigenous sleep device (wahakura) for infants at high risk for sudden unexpected death with a bassinet, for measures of infant sleep position, head covering, breastfeeding, bed-sharing, and maternal sleep and fatigue.

METHODS: A total of 200 mainly Māori pregnant women were recruited from deprived areas of New Zealand. They were randomized to receive a bassinet or wahakura and asked to sleep the infant in this device from birth. Questionnaires at 1, 3, and 6 months and an overnight infrared video in the home at 1 month were completed.

RESULTS: An intention-to-treat and an “as-used” analysis of questionnaires showed no group differences at 1, 3, and 6 months in infant-adult direct bed-sharing (7% vs 12%, $P = .24$ at 1 month), and at the 6-month interview, the wahakura group reported twice the level of full breastfeeding (22.5% vs 10.7%, $P = .04$). Maternal sleep and fatigue were not significantly different between groups. Video identified no increase in head covering, prone/side sleep position, or bed-sharing in the wahakura group, either from intention-to-treat analysis, or when analyzed for actual sleep location.

CONCLUSION There were no significant differences in infant risk behaviors in wahakura compared with bassinets and there were other advantages, including an increase in sustained breastfeeding. This suggests wahakura are relatively safe and can be promoted as an alternative to infant-adult bed-sharing. Policies that encourage utilization are likely to be helpful in high-risk populations.



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WHAT'S KNOWN ON THIS SUBJECT: Indigenous populations have greater rates of sudden unexpected death in infancy. The high prevalence of bed-sharing where there was smoking in pregnancy is a major contributor to risk. The wahakura (flax bassinet) may be a safer alternative to direct bed-sharing.

WHAT THIS STUDY ADDS: Provision of a wahakura, (indigenous infant sleeping device) did not increase infant risk behaviors or worsen maternal sleep, but did increase reported full breastfeeding at 6 months. This supports wahakura as a relatively safe option with potential wider benefits.

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Infants of indigenous peoples in colonized countries have large disparities in rates of postneonatal death, mainly driven by high rates of sudden unexpected death in infancy (SUDI).^{1,2} This is seen in New Zealand, where Māori postneonatal mortality is 3 times that of non-Māori.³ Strategies aimed at reducing these disparities have often been ineffective.⁴ Although the reasons for the disparity are complex, Māori place considerable cultural value on bed-sharing and also have high rates of maternal smoking (53% vs 8%).⁵ This combination of maternal smoking in pregnancy and subsequent bed-sharing has been shown to increase risk of sudden infant death syndrome approximately 10-fold compared with infant solitary sleep with no smoke exposure,^{6,7} and both factors have proved resistant to change.

In 2006, a traditionally woven bassinet-like sleeping device (wahakura) was developed in the Māori community.^{8,9} Its portability and flat-bottomed design allow it to be placed anywhere, and it provides a consistent infant sleeping environment. It also can be used in (or on) a shared adult bed, maintaining the close maternal proximity afforded by bed-sharing, while creating a walled separate sleeping surface thought to be inherently safer than direct bed-sharing (bed-sharing without a protective device).¹⁰ It can be used for infants up to 5 or 6 months old, the main risk period for SUDI, and is distributed with an evidence-based set of safe sleeping rules.

Although there is evidence of the acceptability and utility of the wahakura as an infant sleeping space,¹¹ to date there is no research regarding its benefits or harm.

METHODS

This study was designed to examine the relative safety and other benefits,

or harm, from a wahakura compared with a stand-alone bassinet when provided to mainly Māori families. It compared recognized dangers in the infant sleep environment (head covering, bed-sharing, and prone or side infant sleep position); a known protective factor (breastfeeding) and other possibly important influences (mother-infant interactions, infant behavioral arousals, maternal sleep and fatigue, and infant well-being).

We hypothesized that use of a wahakura would reduce time spent bed-sharing on the same sleeping surface with another person, increase breastfeeding duration, not influence infant sleep position, overnight head covering, sleep time, or infant illness, nor maternal sleep or maternal fatigue, but increase overnight breastfeeding and mother-baby interactions.

Ethical approval to conduct this study was granted by the New Zealand Central Region Ethics Committee (CEN/10/12/054). Full methodological details are published elsewhere.⁸

Participants

We recruited 200 of 600 eligible participants from 2 midwifery practices supporting mainly Māori women in low socioeconomic areas in New Zealand. Women were recruited during pregnancy between June 2011 and April 2013. Healthy, term infants from singleton pregnancies were included, and Fig 1 shows the flow of participants through the study. Full details of the power calculations and exclusion criteria are described elsewhere.⁸ Briefly, we based the sample size on earlier estimates of the frequency of head covering¹² and breastfeeding.¹³ Eighty-eight infants were required to show a difference of 15% between the groups, assuming a rate of head covering of 3% for those sleeping in a bassinet, and 106 infants per group were required to show a 20% difference in breastfeeding, by using

5% level of significance and 80% power.

There was no difference between nonconsenting and consenting groups with respect to age, parity, and deprivation score,¹⁴ although a higher proportion of eligible Māori consented to participate compared with New Zealand European.

After informed consent, the women completed a baseline questionnaire and were randomized (stratified by parity and deprivation quintile) by using sealed sequentially numbered envelopes to either a wahakura ($n = 102$) or a bassinet ($n = 98$). The research nurse enrolling the participants opened the envelope and provided the participants with the appropriate device. The randomized order was generated by the statistician by using random-length blocks. Researchers were not blind to the allocated group. After exclusions, the overall recruitment rate was 35.4%.

Sleep Devices

The wahakura is a woven 36 × 72-cm flax bassinet. A similar-sized standing bassinet was used, custom designed in New Zealand for distribution to infants at high risk of SUDI (Fig 2). Both devices were highly portable and contained identical 20-mm foam sponge mattresses with a washable mattress cover. Devices were provided during pregnancy with evidence-based safe-sleep instructions.⁸ Parents were instructed to use the device in the parental bedroom overnight and to always use the allocated sleeping device, regardless of the room the infant was in or where the wahakura was placed (eg, floor, shared bed, couch), including when the infant was looked after by other caregivers.

Data Collection

Data were collected by using machine-readable questionnaires (HP TeleForm 2014; Hewlett-Packard Development Company,

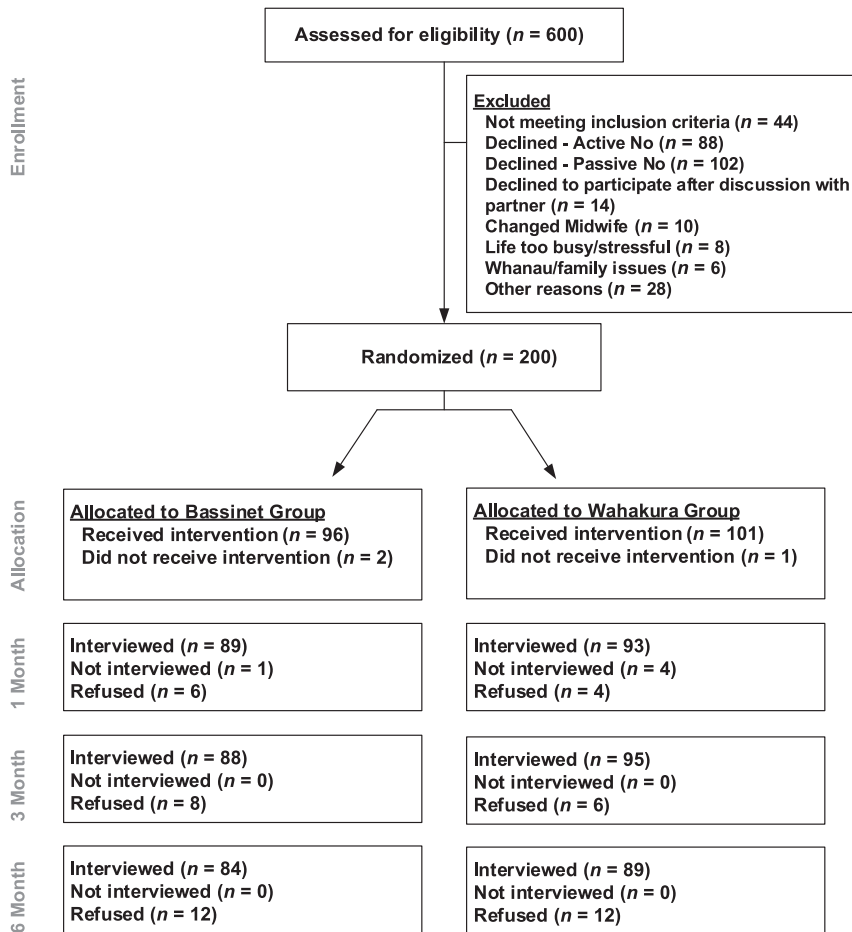


FIGURE 1
CONSORT diagram.



FIGURE 2
The wahakura and bassinet provided to participants.

LP, Houston, TX) administered by a local Māori research nurse at recruitment (baseline) and at 1, 3, and 6 months of age. A saliva sample was collected from the mother at baseline for cotinine analysis to provide an objective measure of maternal smoking in pregnancy and to confirm that we had engaged a high-risk community

for whom the study results would be applicable. In addition, at 1 month, a researcher visited the home and set up the sleep study to measure infant/maternal behavior by using digital infrared video camera(s) and recorder(s) (Swann wireless ADW-400, Richmond, Victoria, Australia). Overnight infant temperature and pulse oximetry also were recorded

and will be reported elsewhere. One camera was set up above the parental bed, and if the infant slept elsewhere, another camera was also set up above the infant sleep device. The 1-month questionnaire was completed in the morning when the researcher returned to pack up the sleep study. For participants who declined the sleep study, the researcher visited the home at 1 month to complete the questionnaire. The 3-month questionnaire also was a face-to-face interview and the 6-month questionnaire was administered by telephone.

Participants were given a NZ\$50 grocery voucher after the 1-month sleep study, and NZ\$25 vouchers on completion of each of the 3- and 6-month interviews.

Outcome Measurement

The outcomes of interest were usual overnight direct bed-sharing in the past week, main sleeping place over the past week, full breastfeeding at 3 and 6 months, sleep position, maternal sleep quality and quantity, maternal fatigue, and infant illness and medication use.

Maternal sleep was measured using 4-point scales previously developed by the researchers.¹⁵ Separate questions were asked about quantity (1 = not nearly enough, 2 = not quite enough, 3 = enough, 4 = more than enough) and quality (1 = very bad, 2 = fairly bad, 3 = fairly good, 4 = very good) of sleep over the past week. Fatigue was measured at 1 and 3 months, by using a slightly modified version of the Fatigue Assessment Scale.¹⁶

Maternal salivary cotinine was collected 10 minutes after mouth rinsing by using a straw to put the saliva in three 1.5-mL containers that were kept on ice until spun and the supernatant frozen for later analysis. Subsequently, a 30- μ L aliquot was injected into a liquid chromatography-mass

spectrometry system (AbSciex 3200 QTrap with Agilent 1200 series LC, Framingham, MA) tuned to monitor cotinine, nicotine, and an internal standard. Within-run coefficients of variation ranged from 3.5% to 5.2% and between-batch coefficients of variation ranged from 3.8% to 8.6%. Cotinine-verified smoke exposure was defined as levels >10 ng/mL.¹⁷

Sleep Studies

Video recordings were viewed off-line by using Noldus Observer XT (Wageningen, Netherlands) video analysis software and coded according to a taxonomy adapted from our previous studies¹² and that used at Durham University (H. Ball, personal communication, 2012). Key categories included infant head covering, sleep position, location and time, behavioral arousals, breastfeeding, maternal-infant interactions, and time direct bed-sharing.

Off-line coding of data started when the infant was first asleep. Start and stop times for behavioral categories were logged until the final waking of the infant in the morning. Sleep was identified as starting after the infant appeared asleep for 2 minutes. Time when the infant woke and returned to a settled state within 2 minutes was included as sleep. Waking for more than 2 minutes was defined as a behavioral arousal. Other behaviors were logged if they occurred for more than 30 seconds, except for point categories (visual check, physical inspection, infant picked up, and infant given pacifier). Breastfeeding, bottle-feeding, and pacifier use were considered single episodes if the infant returned to the breast/bottle/pacifier in <30 seconds.

Subcategories were defined for head-covering events: fully covered (above the eyes), partially covered (covering the mouth and nose), and sleep location: wahakura on the bed (under or not under adult covers), wahakura not on the bed, bassinet, adult bed,

cot, and other. Sleep time was the accumulation of the infant sleep periods during the study time.

Potential risks that were not part of the predetermined coding scheme were identified in the comments section of the video coding.

Reliability of Coding

All videos were coded by the same researcher and 20 videos were coded a second time. The intraclass correlation coefficient was used to assess agreement between the original video and the re-scored videos. The intraclass correlation coefficient was 0.95 (95% confidence interval [CI] 0.91–0.99) for the observation time, 0.96 (95% CI 0.92–0.99) for the time the infant slept, 0.63 (95% CI 0.37–0.90) for the time infant spent in the mother's bed, 0.77 (95% CI 0.58–0.94) for the amount of time the infant's head was covered, and 0.80 (CI 0.63–0.96) breastfeeding time.

Kappa was used to assess the agreement between the categorical variables. There was complete agreement for the presence or absence of breastfeeding ($\kappa = 1$). The κ for whether the infant's head was covered was 0.78 (95% CI 0.32–1.00) and 0.71 (95% CI 0.26–1.00) for whether the infant's sleep position was side or prone.

Statistical Analyses

Modified intention-to-treat analysis (participants were included if they had at least 1 of the 1-, 3-, or 6-month observations) was used to analyze the questionnaire data. χ^2 tests also were used to compare the 2 groups for differences in sleep position, breastfeeding, maternal sleep quantity and quality, infant health, and infant medication at each of the 3 time points. Modified intention-to-treat also was used for the sleep study. In this case, regression analysis adjusting for either the length of the study or the length of time the infant was

asleep, as appropriate, was used to compare the groups. Generalized linear models (logistic or negative binomial), adjusting for the length of the study or sleeping time, were used to compare the frequency of groups of infants with 4 different sleeping patterns for behaviors of interest. Stata software, release 13 (Stata Corp, College Station, TX) was used for all statistical analyses.

RESULTS

Retention rates for the bassinet group were 92.7%, 91.7%, and 87.5% at the 1-, 3-, and 6-month interviews, with a mean infant age in days (SD) at the time of each interview being 51 (21.1), 105 (24.6), and 200 (25.9), respectively. Retention rates for the wahakura group were 92.1%, 94.1%, and 88.1%, with mean ages (SD) at interview of 52 (29.2), 111 (33.2), and 207 (38.9) days. There were no infant deaths among participants during the study.

The characteristics of the wahakura and bassinet groups at baseline are shown in Table 1. Most of the mothers were of Māori ethnicity, had already given birth to at least 1 child, had not completed any form of tertiary education, and lived in a socioeconomically deprived area. "Any smoking" during pregnancy was commonly reported (bassinet: 55% vs wahakura: 57%), whereas salivary cotinine at the baseline assessment suggested that 36% of the bassinet group and 51% of the wahakura group were actively smoking at this time.

Usually sleeping in the mother's bed overnight (without a wahakura) was reported at 1 month (bassinet: 7% vs wahakura: 12%, $P = .24$), 3 months (11% vs 15%, $P = .46$), and 6 months (23% vs 19%, $P = .57$) with no significant differences between the bassinet and wahakura groups (Table 2). Compliance with allocated sleep device was greater in the bassinet group compared with the

TABLE 1 Baseline Characteristics in the Bassinet and Wahakura Groups

Characteristics	Bassinet, <i>n</i> = 96		Wahakura, <i>n</i> = 101	
	<i>n</i>	%	<i>n</i>	%
Parity				
0	32	33.3	35	34.7
1	27	28.1	30	29.7
2 or 3	28	29.2	27	26.7
4 or more	9	9.4	9	8.9
Ethnicity				
Māori	64	66.7	75	74.3
Pacific Island	7	7.3	9	8.9
New Zealand European	20	20.8	14	13.9
Other	5	5.2	3	3.0
Education				
Completed primary school to year 11	47	49.0	46	45.5
Completed year 12 (required level)	7	7.3	19	18.8
Completed year 13 (finished high school)	12	12.5	4	4.0
Trade certificate or similar	8	8.3	7	6.9
University or tertiary degree	17	17.7	15	14.9
Other	5	5.2	10	9.9
Deprivation score				
1 or 2	5	5.2	6	5.9
3 to 4	2	2.1	4	4.0
4 to 6	18	18.8	20	19.8
7 to 8	10	10.4	15	14.9
9 to 10	61	63.5	56	55.5
Marital status				
Single	28	29.2	30	29.7
Separated/divorced	5	5.2	0	0.0
Married/civil union/de facto relationship	63	65.6	71	70.3
Smoking status				
Never smoked	27	28.1	25	24.8
Quit smoking >1 y ago	16	16.7	18	17.8
Quit smoking during pregnancy	9	9.4	11	10.9
Occasional smoker	14	14.6	11	10.9
Daily smoker	30	31.3	36	35.6
Cotinine				
Nonsmoker	55	64.0	44	49.4
Smoker	31	36.0	45	50.6
Cigarettes/d				
<1	56	58.3	58	57.4
1 to 5	19	19.8	17	16.8
6 to 10	15	15.6	20	19.8
≥11	6	6.3	6	5.9
Infant sex				
Boy	48	50.0	51	50.5
Girl	48	50.0	50	49.5
Infant ethnicity				
Māori	72	75.0	75	74.3
Pacific Island	5	5.2	10	9.9
New Zealand European	17	17.7	14	13.9
Other	2	2.1	2	2.0
Type of delivery				
Vaginal	74	77.1	70	69.3
Vaginal and assistance	3	3.1	7	6.9
Caesarean	19	19.8	24	23.8
	Mean	SD	Mean	SD
Maternal age, y	26.5	6.3	25.9	6.2
Gestation, wk	39.5	1.2	39.2	1.4

Infants were randomized to wahakura or bassinet. The CONSORT guidelines suggest that a *P* value is not required in this situation.

TABLE 2 Infant Overnight Sleeping Behavior (in the Past Week) as Reported by Mothers

	1 Month, n = 182			3 Months, n = 183			6 Months, n = 173					
	Bassinet, n = 89		Wahakura, n = 93		Bassinet, n = 88		Wahakura, n = 95		Bassinet, n = 84		Wahakura, n = 89	
	n	%	n	%	n	%	n	%	n	%	n	%
Room where infant slept												
Maternal bedroom	80	89.9	81	87.1	72	81.8	78	82.1	60	71.4	67	75.3
Another bedroom	9	10.1	12	12.9	16	18.2	17	17.9	24	28.6	22	24.7
Principal overnight sleeping place												
P		.56				.96						.57
Mother's bed	6	7	11	12	10	11	14	15	19	23	17	19
Bassinet	55	62			40	45			9	11	6	7
Wahakura	0	0	38	41	1	1	25	26	0	0	6	7
Cot	15	17	17	18	30	34	31	34	50	60	56	63
Own bassinet	8	9	24	26	4	5	19	20	1	1	1	1
Mattress on floor	2	2			1	1	1	1				
Pepipod	1	1	1	1	1	1	1	1			0	
Portacot	1	1	1	1	1	1	1	1	3	4	3	3
Couch			1	1	1	1						
Single bed							2	2	2	2		
Sibling's bed							1	1				

Pepipod, a plastic in-bed sleeping device similar in size to a wahakura; Portacot, portable cot-sized sleeping device placed on the floor.

wahakura group at each interview: 1 month (bassinet: 62% vs wahakura: 41%), 3 months (bassinet: 45% vs 26%), and 6 months (bassinet: 11% vs wahakura: 7%) (Table 2). Corresponding to the decline in use of the allocated sleeping device was a pattern of increased use of a cot in both groups. Detailed analysis shows >60% slept >5 hours over the past 24-hour period in a cot at 6 months (Supplemental Table 9).

The differences between the bassinet and the wahakura groups for the infant being fully breastfed at the 1-, 3-, and 6-month interviews were -7.6% (-22.1 to 6.8), 0.9% (-13.3 to 15.0), and -12% (-1 to -23), respectively. At the 6-month interview, 22.5% of the wahakura group were still fully breastfeeding compared with 10.7% of the bassinet group (P = .04). There were no significant differences in infant sleep position at 1, 3, and 6 months, with more than 80% of infants sleeping on their back at all ages (Table 3).

Maternal sleep quantity and quality did not differ between groups, with approximately 60% to 70% of mothers getting enough sleep and >90% describing good-quality sleep. Mean maternal fatigue item scores at 1 month, were 1.8 (0.5) and 1.7 (0.5) for the bassinet and wahakura groups, respectively, and were not significantly different. Parental report of any infant illness or infant medication use since last contact was not different between groups apart from medication use in the first month, in which there was 19.8% (95% CI 7.4-32.1, P < .01) more medication use in the wahakura group (Table 3).

In an "as-used" analysis, the sample was divided into groups according to where the infants usually slept overnight in the week before the 1-month assessment. Eighty-eight infants "usually slept" in a bassinet, 38 in a wahakura, and 17 infants slept in their mother's bed. The differences among these groups for

TABLE 3 Infant Sleeping Position, Maternal Sleep Quantity and Quality, Breastfeeding, Infant Health and Medication, in the Bassinet and Wahakura Groups at 1, 3, and 6 Months as Reported by Mothers

	1 Month, n = 182			3 Months, n = 183			6 Months, n = 173					
	Bassinet, n = 89		Wahakura, n = 93		Bassinet, n = 88		Wahakura, n = 95		Bassinet, n = 84		Wahakura, n = 89	
	n	%	n	%	n	%	n	%	n	%	n	%
Infant sleep position												
Side	13	14.6	10	10.8	10	11.4	8	8.4	3	3.6	6	6.7
Back	72	80.9	77	82.8	73	83.0	81	85.3	71	84.5	77	86.5
Front	4	4.5	6	6.5	5	5.7	6	6.3	10	11.9	6	6.7
Maternal sleep quantity												
Not enough	36	40.4	38	40.9	26	29.5	30	31.6	27	32.1	28	31.5
At least enough	53	59.6	55	59.1	62	70.5	65	68.4	57	67.9	61	68.5
Maternal sleep quality												
Bad	4	4.5	4	4.3	9	10.2	7	7.4	10	11.9	6	6.7
Good	85	95.5	89	95.7	79	89.8	88	92.6	74	88.1	83	93.3
Fully breastfeeding												
Yes	42	47.2	51	54.8	35	39.8	37	38.9	9	10.7	20	22.5
No	47	52.8	42	45.2	53	60.2	58	61.1	75	89.3	69	77.5
Infant unwell												
Yes	31	34.8	35	37.6	41	46.6	53	55.8	58	69.0	50	56.2
No	58	65.2	58	62.4	47	53.4	42	44.2	26	31.0	39	43.8
Infant medication												
Yes	14	15.7	33	35.5	35	39.8	46	48.4	49	58.3	57	64.0
No	75	84.3	60	64.5	53	60.2	49	51.6	35	41.7	32	36.0

^a Fisher's Exact Test used if expected cell counts <5.

sleep position, breastfeeding, quality or quantity of mothers' sleep, fatigue, and infant being unwell or using medication were not statistically significant.

Parents were asked about their use of, and experience of using, their allocated sleep devices at the end of the study. All parents would recommend their allocated sleeping device to other parents and similar proportions would use it for their next infant (wahakura 66.3%, bassinet 65.3%) and 58.4% of those allocated the wahakura said they used it for most sleeps compared with 65.5% of the bassinet group. When asked, at 6 months, what they did not like about the sleep device, the most common aspects were device too small and infants grew out of it too fast (bassinet: 7.1%, wahakura: 15.7%), device did not appeal (bassinet: 14.3%, wahakura: 13.5%), did not like aspects of the construction (bassinet: 14.3%, wahakura: 12.5%).

Video

Successful video recordings at the 1-month sleep study occurred for 80 (83%) of 96 of the bassinet group and 79 (78%) of 101 of the wahakura group. The mean infant age was 50 days (SD 19.1) (bassinet group) and 47 days (15.7) (wahakura group). There was no significant difference in mean study time between the bassinet and wahakura groups (0.22 hour [95% CI -0.73 to 1.17]), nor in mean total overnight sleep time.

Most infants (86%) allocated a bassinet, slept in the bassinet (mean 7.8 hours) on the study night. Eighty-five percent of infants also spent time in the mother's bed (mean 2.1 hours) and 3 infants spent a mean of 4.5 hours in a cot. None of these infants spent any time in a wahakura. Two-thirds of the infants allocated a wahakura slept in the wahakura (mean 7.4 hours) and a quarter of them slept in a bassinet (mean 7.4 hours). Eighty-five percent of infants

TABLE 4 Total Time, Sleep Time, and Time in Sleep Environments for Infants Randomized to Bassinet and Wahakura as Observed on Video

Infant Sleep Location	Bassinet, <i>n</i> = 80		Wahakura, <i>n</i> = 79		Difference, Wahakura – Bassinet (95% CI)	<i>P</i>
	<i>n</i> (%)	Mean Time (SD)	<i>n</i> (%)	Mean Time (SD)		
Study time, h		9.9 (3.23)		10.1 (2.80)	0.22 (–0.73 to 1.17)	.65
Appears asleep, h		6.6 (2.65)		6.7(2.40)	–0.07 (0.57 to 0.43)	.78
Times for infants who slept in						
Bassinet	69 (86)	7.8 (3.22)	21 (27)	7.4 (2.82)		
Wahakura	0		45 (57)	7.4 (2.97)		
On bed			22 (28)	6.4 (3.97)		
Off bed			23 (29)	6.9 (2.97)		
Mother’s bed	68 (85)	2.1 (2.35)	67 (85)	2.3 (2.63)		
Cot	3 (4)	4.5 (3.84)	5 (6)	7.8 (3.61)		
Sleep in mother’s bed for groups as randomized		1.7 (2.29)		2.0 (2.56)	0.18 (–0.57 to 0.93)	.64

TABLE 5 Number of Infants Observed in Various Behaviors, as Randomized to Wahakura or Bassinet (Intention-to-Treat Analysis)

Infant Sleep Behavior	Bassinet		Wahakura		Odds Ratio (95% CI)	<i>P</i>
	<i>n</i> = 80	<i>n</i> = 79				
	<i>n</i> (%)	<i>n</i> (%)				
Any head covering	27 (34)	26 (33)			0.94 (0.48–1.84)	.85
Fully covered	16 (20)	19 (24)				
Partially covered	23 (29)	21 (27)				
Breastfeeding	51 (64)	48 (61)			0.78 (0.40–1.51)	.46
Bottle-feeding	27 (34)	29 (37)			1.10 (0.57–2.14)	.77
Pacifier use	20 (25)	19 (24)			0.92 (0.44–1.91)	.93
Mother-infant interactions	79 (99)	78 (99)			1.20 (0.25–5.70)	.92
Visual check	1 (1)	6 (8)				
Deliberate physical inspection	3 (4)	5 (6)				
Active settling by parent	8 (10)	12 (15)				
Infant picked up	77 (96)	72 (91)				
Infant given dummy/pacifier	23 (29)	20 (25)				
Side or prone	37 (46)	40 (51)			1.05 (0.54–1.99)	.89
Side	31 (39)	32 (41)				
Prone face down	3 (4)	5 (6)				
Prone face side	5 (6)	7 (9)				
Prone on adult	11 (14)	10 (13)				

P value for an overall test between the groups by using logistic regression to adjust for total sleep time or total observation time as appropriate.

spent some time (mean 2.3 hours) in their mothers’ beds, whereas 5 infants slept in a cot (mean 7.8 hours). The wahakura was placed in different places: on top of adult bedding (16 infants) or under adult bedding (6 infants), or somewhere other than on the adult bed (23 infants). The difference between allocated groups for time spent in mother’s bed was not significant (0.18 hour [–0.57 to 0.93]) (Table 4).

Intention-to-Treat Analysis

The number of infants in each group displaying risk or protective behaviors was not significantly different (Table 5). Overall, one-third of infants experienced head-covering events, two-thirds were breastfed, and a quarter of infants used a pacifier. All engaged in mother-infant interactions. Fifty percent of each group slept for some time

on their side or prone; mainly side sleep with some sleeping prone face down (bassinet: 3 infants versus wahakura: 5), prone with face to the side (bassinet: 5 vs wahakura: 7), or prone on an adult (bassinet: 11 vs wahakura: 10).

As-Used Analysis

The sample was divided into groups according to where they slept on the study night. Infants were assigned to mother’s bed if they slept there all night, to wahakura if they slept there for any time, and the remainder were assigned bassinet/cot. Bassinet/cot accounted for 101 infants, 45 slept in a wahakura (22 on the maternal bed, 23 not on the bed, 4 of which were not in the parental bedroom), and 12 slept in mother’s bed. The results are presented in Tables 6, 7, and 8 and show that for most behaviors, the differences among the groups are small and not statistically significant. However, the number of head-covering events was lower in the wahakura not on the bed group (overall *P* = .05) (Table 7), whereas the duration of side or prone sleeping was greater in the bed-sharing group (*P* = .03 for the overall comparison) (Table 8).

Potential Risk Events

A small number of additional potential risks were identified across all sleep locations. Partial wall collapse of the wahakura was observed 3 times from the 45 nights of recording. Four researchers observed the video segments and agreed they were unlikely to pose a significant risk to the infant.

In addition, 2 bed-sharing infants slept near the edge of the adult bed, 1 mother fell asleep partially obscuring the infant head with her hand, and 5 infants slept under loose bedding in wahakura and bassinets.

DISCUSSION

As postneonatal and SUDI rates are disproportionately high among indigenous populations, risk-reduction strategies need to be culturally appropriate and targeted to high-risk populations.¹⁸ This study examined the safety, other benefits, and/or risks, of the wahakura, a New Zealand Māori infant sleeping device.

Our key findings were no increase in the SUDI risk factors of head covering or prone/side sleep position from use of the wahakura compared with the current gold standard of safe infant sleep: a bassinet beside the mother's bed. We noted no differences in maternal sleep or fatigue levels related to device allocation, but mothers using the wahakura reported a significantly higher rate of full breastfeeding by 6 months. Provision of a wahakura did not decrease infant-adult bed-sharing in comparison with provision of a bassinet. We do not, however, know what the rate of infant-adult bed-sharing would have been in this group had they not been given any device.

There was reasonable consistency between self-reported bed-sharing at 1 month, and observed overnight bed-sharing (10% of mothers reported their infants mainly slept in the mother's bed over the previous week, and video showed 7.5% spent all night in the mother's bed). For comparison, 13% of a cohort of Māori mothers ($n = 299$) interviewed by phone about infant sleep practices reported sharing a bed for >5 hours on the previous night.⁵ Although comparisons of different cohorts at different times is problematic, our bed-sharing results suggest a possible benefit of providing either a wahakura or bassinet to Māori families. We did not collect data about why mothers chose to bed-share after being allocated a wahakura or bassinet, but Māori families from the previously cited study reported "prefer the closeness"

TABLE 6 Number of Infants Observed in Various Behaviors While Using a Bassinet/Cot, Wahakura (Off or on the Adult Bed) or Mother's Bed (As-Used Analysis)

	Used a Bassinet or Cot, $n = 101$	Used a Wahakura Off Bed, $n = 23$	Used Wahakura on/in Bed, $n = 22$	Mother's Bed, $n = 12$	<i>P</i>
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
Any head covered	36 (36)	2 (9)	10 (45)	5 (50)	.10
Fully covered	25 (25)	2 (9)	6 (27)	2 (17)	
Partially covered	28 (33)	1 (4)	10 (45)	5 (50)	
Breastfed	60 (59)	13 (57)	16 (73)	9 (75)	.65
Bottle-fed	36 (36)	9 (40)	10 (45)	1 (8)	.22
Side/prone sleeping	50 (49)	5 (22)	13 (55)	8 (67)	.08
Pacifier use	25 (25)	8 (35)	5 (23)	1 (8)	.33
In mother's bed	87 (86)	15 (65)	21 (95)	12 (100)	

P value for an overall test among the groups using logistic regression to adjust for total sleep time or total observation time as appropriate.

TABLE 7 The Number of Times Behaviors of Interest Were Observed (Mean [SD]) for Infants Who Slept in a Bassinet, Wahakura, or Mother's Bed (As-Used Analysis)

	Used a Bassinet, $n = 101$	Used a Wahakura Off Bed, $n = 23$	Used Wahakura on/in Bed, $n = 22$	Mother's Bed, $n = 12$	<i>P</i>
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Any head covered	2.1 (4.56)	0.4 (1.30)	2.2 (4.17)	1.6 (2.27)	.051
Fully covered	0.6 (1.73)	0.2 (0.58)	0.7 (1.25)	0.6 (1.37)	
Partially covered	1.4 (3.21)	0.2 (0.83)	1.5 (3.2)	1.0 (1.35)	
Breastfeeding	3.4 (4.52)	3.3 (4.15)	3.8 (3.51)	4.5 (3.66)	.99
Bottle-feeding	1.2 (2.47)	1.3 (2.39)	1.7 (2.12)	0.3 (1.15)	.20
Side/prone sleeping	1.2 (1.75)	0.6 (1.20)	1.8 (3.22)	3.2 (3.551)	.14
Mother-infant interaction (visual checks)	15.5 (13.8)	18.2 (17.8)	21.1 (14.3)	13.4 (10.5)	.23
Behavioral arousals	2.3 (1.4)	2.2 (1.4)	2.7 (1.5)	2.0 (1.0)	.41
Pacifier use	1.9 (4.12)	2.2 (4.2)	2.3 (5.6)	0.1 (0.3)	.15

P value for an overall test among the groups using negative binomial regression adjusting for total sleep time or total observation time as appropriate.

and "for breastfeeding," while not identifying concerns about safety.

The higher rate of sustained breastfeeding in the wahakura group has significant individual and public health implications and may be due to increased mother-infant proximity with the wahakura on the adult bed, similar to that reported from mother-infant dyads that regularly bed-share.¹⁹ However, we were not able to demonstrate the impact of proximity in the sleep study at 1 month because half of the wahakura were placed on the mother's bed and half were placed elsewhere. The breastfeeding time on the study

night, in all groups, was comparable to that reported elsewhere for solitary sleeping infants (mean 24 minutes).²⁰ A much larger study would be required to show a difference between wahakura on the bed and off the bed.

Consistent with our hypotheses, there were no significant differences in room-sharing or prone/side sleeping related to device allocation or use, either self-reported or observed. Head covering^{6,21} is strongly associated with SUDI. Approximately one-third of all infants experienced some head covering overnight, whereas only

TABLE 8 Study Time, Time Infant Slept and Time for Behaviors of Interest (Mean [SD]) for Infants Who Slept in a Bassinet, Wahakura, or Mother's Bed as Observed on Video (As-Used Analysis)

	Used a Bassinet or Cot, <i>n</i> = 101	Used a Wahakura Off Bed, <i>n</i> = 23	Used a Wahakura on/ in Bed, <i>n</i> = 22	Mother's Bed, <i>n</i> = 12	<i>P</i> ^a
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Time for study, h	9.9 (3.17)	9.4 (3.18)	10.2 (2.86)	10.8 (1.31)	.58
Time asleep, h	6.7 (2.51)	5.9 (2.80)	6.4 (2.55)	7.8 (1.11)	.15
Any head covered, min	26 (62)	22 (104)	32 (54)	33 (65)	.96
Fully covered, min	15 (53)	22 (105)	10 (19)	23 (61)	
Partially covered, min	10 (25)	0.4 (2.0)	23 (48)	10 (29)	
Breastfeeding, min	24 (35)	16 (23)	24 (28)	45 (61)	.22
Bottle-feeding, min	5 (10)	12 (30)	34 (116)	2 (8)	.06
Side/prone sleeping, min	87 (173)	14 (44)	96 (166)	199 (210)	.03
In mother's bed, min ^b	96 (116)	66 (77)	102 (102)	342 (288)	
Pacifier use	16 (41)	18(39)	26 (85)	0 (0)	.51

^a *P* value for an overall test among the groups using linear regression to adjust for total sleep time or total observation time as appropriate.

^b No *P* value, as being in the mother's bed defined one of the groups.

1 infant (2.5%) was observed with head covered in our previous study of infants of largely New Zealand European ethnicity, sleeping overnight in a bassinet.¹² However, infants did not experience more head covering when allocated or using a wahakura compared with the bassinet.

Side or prone sleep was more common in the bed-share group, although almost 50% of all infants spent some time sleeping on their side or prone, both positions being associated with increased risk of SUDI.^{6,22} This contrasts with little side or prone sleeping seen in observational studies of infants sleeping in stand-alone cots/ bassinets,^{12,23,24} but is consistent with the view that there is less knowledge of risk factors among Māori compared with other groups.⁵ Health professionals have identified the wahakura as a useful way to engage with Māori women antenatally¹¹ and thus strengthen knowledge about safe sleep.

There also were no differences in maternal sleep or fatigue levels related to device allocation. Parents

in this study generally perceived that they had adequate-to-good sleep, in contrast to other studies, which suggests socioeconomic disadvantage is strongly associated with sleep problems.^{25,26}

There was no difference in reported infant illnesses between study groups but, curiously, infants in the wahakura group used significantly more medicines. This could relate to closer parental-infant contact by using the wahakura, causing some increased perception of sleep problems or illness and subsequent use of medication.

Although there is the potential for wall collapse, we did not observe any event that appeared dangerous. The wahakura provides an infant-only space whether used in the adult bed or in a bassinetlike fashion. The value of this device is that it has cultural significance for Māori, being woven of flax, and with promotion may reduce direct bed-sharing in this population at increased risk of SUDI. We cannot, however, rule out the possibility of wall collapse.

Strengths

This randomized controlled trial is the first of its kind investigating the safety of an indigenous sleep device that has been promoted as a safer alternative to direct bed-sharing. Previous SUDI prevention research targeting indigenous or high-risk populations has focused on risk-awareness strategies^{27,28} and targeted educational intervention.²⁹

This comprehensive study included questionnaires and overnight video (and yet-to-be reported infant physiologic measures). Given the caution of many indigenous populations in participating in research, a major strength of the current study is the relatively high recruitment and retention of this “mainly Māori” sample of mothers. The study was intrusive with 4 interviews and camera(s) in the bedroom, and we believe that our 35.4% recruitment rate is creditable. Furthermore, once recruited into the study, retention was very high for both groups.

Limitations

The use of both allocated devices was lower than we expected; more so, with the wahakura. We did not collect data on reasons for not using either device, but we note that parents used other devices, such as their own bassinet or a cot. We posit low use might have been because parents and grandparents were unfamiliar with the wahakura and this particular portable bassinet. Although this was more pronounced with the wahakura, we argue that the reassuring data from this study allows community groups and health professionals to be comfortable with recommending wahakura. The relatively low recruitment rate means that the findings of this study may not apply to the population in general. Māori, the population of interest, were more likely to participate.

Variability in the video data, represented by wide CIs and large SDs, limits the conclusions that can be drawn about differences between the groups, but are consistent with similar overnight observational studies of infants, and there was high reliability between the coding and recoding of videos.

Implications

The wahakura is an SUDI intervention developed by Māori for Māori. Our study suggests that there is no increased risk with the use of the wahakura compared with a bassinet, currently regarded as the gold standard for infant sleep

location. Promoting use of this device may be a more effective strategy for combating SUDI in this high-risk population than current emphasis on discouraging culturally embedded practices, such as bed-sharing, which have proven resistant to change.

CONCLUSIONS

There were no significant differences in infant risk behaviors in wahakura compared with bassinets and there were other advantages, including an increase in sustained breastfeeding. This suggests wahakura are relatively safe and can be confidently promoted as an alternative to infant-adult bed-sharing. Policies that encourage

utilization are likely to be helpful in this high-risk population.

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ABBREVIATIONS

CI: confidence interval
SUDI: sudden unexpected death in infancy

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