RESEARCH

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THIS WEEK'S RESEARCH QUESTIONS

- 1247 Is reduced sleep associated with a risk of becoming overweight in children?
- 1248 Are the initial improvements in obstructive sleep apnoea seen after a weight loss diet maintained after one year?
- 1249 Is surgery with disc prosthesis as effective as rehabilitation for patients with chronic low back pain and degenerative discs?
- 1250 Do patients who present to emergency departments during shifts with long waiting times, and are not admitted, come to any harm?

Sleep and size

Two papers in this week's *BMJ* deal with the relation between obesity and sleep. Philippa Carter and colleagues' study of young children (age 3-7) found that those who slept less were more likely to have a higher body mass index and greater fat mass in later childhood, even after adjustment for several potential confounding factors. These results



strengthen the evidence for a causal link between sleep and body fat. In a linked editorial (p 1217) Francesco Cappuccio and Michelle Miller discuss possible mechanisms, along with the strengths and limitations of the study.

Meanwhile, being obese as an adult is associated with sleep apnoea, and some evidence suggests that losing weight can improve the condition. In a recent randomised controlled trial Kari Johansson and colleagues found that a very low energy diet improved moderate to severe obstructive sleep apnoea in obese men (*BMJ* 2009;339:b4609). However, a linked editorial commented that "The trial was only nine weeks long, which leaves open the question of the long term sustainability of the weight loss" (*BMJ* 2009;339:b4363).

Addressing this question, the group has now followed up the trial participants for a year—during which the patients took part in a weight loss maintenance programme—and found that the initial reduction in severity of obstructive sleep apnoea was largely maintained (p 1248). About half the 63 patients no longer required continuous positive airway pressure; and a tenth had total remission. Patients who lost most weight improved the most, as did those who had the worst sleep apnoea at baseline. This week's Clinical Review (p 1251) gives more guidance on how to treat patients with sleeping difficulties caused by obstructive sleep apnoea and other problems.

Clinical risks of overcrowded emergency departments

Might Astrid Guttmann and colleagues' retrospective cohort study in Ontario also inform the debate on waiting times in A&E in the NHS? The authors used routine data and record linkage to assess the risk of adverse events among nearly 14 million people who were triaged by nurses at 125 busy Ontario emergency departments in 2003-8 and were either "seen and discharged" or "left without being seen [by a doctor]" (p 1250). Triage scores were grouped as high acuity (1-3: needing resuscitation, emergent, and urgent) and low acuity (4-5: less urgent and non-urgent). Absolute rates of death and admission to hospital within the next seven days were very low at 0.07% and 1.8%, adjusted



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for important confounders affecting patients, shift, and hospital. But the relative risks are still notable and worrying: for high acuity patients who waited \geq 6 versus <1 hour, the adjusted odds ratios were 1.79 (95% confidence interval 1.24 to 2.59) for death and 1.95 (1.79 to 2.13) for admission, and long waits carried similar risks for low acuity patients. More than 600 000 people left without being seen, and clearly made the right decision, as they had no excess risk in the following week.

Editorialist Melissa L McCarthy applauds the study and calls for better tracking of patients' health (and not just their satisfaction) after discharge from emergency departments (p 1220).

Surgical disc prosthesis for chronic low back pain



Christian Hellum and colleagues compare the efficacy of surgery with disc prosthesis versus intensive rehabilitation for patients with chronic low back pain and degenerative intervertebral disc changes. The rehabilitation combined physical and psychological elements, and such programmes have become standard treatment for chronic back pain in many countries. The authors found that patients undergoing disc prosthesis improved more in the primary outcome (disability and pain) than patients treated with rehabilitation, but after two years the result was not clinically significant.

However, the authors and the accompanying editorial by Jeremy Fairbank (p 1218) point out that surgery carries considerable extra risk (including a leg amputation in this study during surgical revision of a dislodged polyethylene disc). Professor Fairbank argues that it seems only sensible that, in the rare cases when back pain does not resolve and becomes chronic, a rehabilitation programme should be tried before resorting to surgery. However, if there is still no improvement and surgery is warranted, then disc replacement seems a promising alternative to spinal fusion.

Longitudinal analysis of sleep in relation to BMI and body fat in children: the FLAME study

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EDITORIAL by Cappucio and Miller **RESEARCH** p 1248 **CLINICAL REVIEW p 1251**

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STUDY OUESTION

Is sleep duration associated with BMI and body composition in children after adjustment for multiple confounders?

SUMMARY ANSWER

Young children who sleep less are more likely to be overweight when they are older, with high body fat values, even after adjustment for lifestyle factors that also influence body weight. After adjustment for confounders, however, the inverse association between sleep duration and concurrent BMI was not significant.

WHAT IS KNOWN AND WHAT THIS PAPER ADDS

How sleep impacts on body composition during growth is not well understood. This study shows that the deleterious association between reduced sleep on later BMI and fat mass remains strong even after adjustment for multiple confounders.

Participants and setting

244 children recruited from a birth cohort (59% response rate) followed from the age of 3 to 7 in Dunedin. New Zealand. Retention of the sample was good, with 83% of the children seen at the age of 7.

Design, size, and duration

Longitudinal study with repeated annual measurements of body composition by anthropometry, dual energy x ray absorptiometry, and bioelectrical impedance. Estimates of sleep (hours/day) and physical activity were obtained from multiple days of accelerometry at 3, 4, and 5 years of age. Diet (non-core foods, fruit and vegetables) and sedentary time (TV viewing) were measured by questionnaire at ages 3, 4 and 5. Information on additional factors including birth weight, smoking during pregnancy, ethnicity, family income, and maternal education and maternal BMI was collected at baseline. All measures were included in the multivariate models.

Main results and the role of chance

Mean sleep duration was about 11 hours per day at ages 3, 4 and 5. BMI at age 3, maternal education, maternal BMI, ethnicity, smoking during pregnancy, and sleep were all significantly associated with BMI at age 7 in univariate analyses. There were no significant associations with sex, physical activity, television viewing and diet. A difference of one hour's sleep duration between the ages of 3 and 5 is associated with a 0.56 (0.07 to 1.06) reduction in body mass index (BMI) at the age of 7. Adjustment for confounders, including BMI at age 3 reduced the estimate to -0.39 (-0.72 to -0.06). This difference in BMI is explained by comparable reductions in the fat mass index (-0.48, -0.86 to -0.10). The corresponding difference in the fat free mass index was -0.11 (-0.29 to -0.07). Each additional hour of sleep also reduced the risk of being overweight (BMI >85th centile) at age 7 by 61% (37% to 76%).

Bias, confounding, and other reasons for caution

Young children who sleep less are more likely to be overweight, with high body fat values, even after adjustment for lifestyle variables that can also influence body weight. Although the temporal relation between sleep and later body weight suggests that the association is causal, unrecognised or non-observed sources of confounding might not have been taken into account as is common with all naturalistic studies.

Generalisability to other populations

Our analyses were undertaken in a predominantly white population with a high prevalence of overweight. Recorded hours of sleep seem to be consistent with other estimates in the literature at this age. We have no reason to believe that our findings would not apply to other similar populations.

Study funding/potential competing interests

This study was funded by the University of Otago, the Child Health Research Foundation, the New Zealand Heart Foundation, and the Dean's Bequest-AAW Jones Trust.

CHANGE (95% CI) IN BMI OR FAT MASS INDEX IN CHILDREN AGED 7 ASSOCIATED WITH A 1 UNIT CHANGE IN EACH INDEPENDENT VARIABLE

Independent variable	BMI	Fat mass index
Sex (male)	-0.75 (-1.08 to -0.44)*	-0.36 (-0.83 to 0.12)
Maternal education (high)	-0.17 (-0.53 to 0.18)	-0.61 (-1.03 to -0.18)*
Maternal BMI	0.03 (0.00 to 0.06)*	-0.00 (-0.04 to 0.03)
Physical activity (1 SD counts/min)	0.12 (-0.11 to 0.34)	-0.12 (-0.39 to 0.15)
TV viewing (hours/day)	0.01 (-0.21 to 0.22)	0.13 (-0.14 to 0.40)
Fruit/vegetable intake (servings/day)	-0.03 (-0.15 to 0.09)	0.01 (-0.14 to 0.16)
Non-core foods intake (servings/day)	-0.00 (-0.15 to 0.15)	-0.09 (-0.27 to 0.09)
Sleep (hours/day)	-0.39 (-0.72 to -0.06)*	-0.48 (-0.86 to -0.10)*
*P<0.05.		

Longer term effects of very low energy diet on obstructive sleep apnoea in a cohort derived from a randomised controlled trial: prospective observational follow-up study

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RESEARCH p 1247 ST CLINICAL REVIEW p 1251 Are

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STUDY QUESTION

Are initial improvements in obstructive sleep apnoea after a very low energy diet maintained after one year in men with moderate to severe obstructive sleep apnoea?

SUMMARY ANSWER

The initial improvements in obstructive sleep apnoea, defined by apnoea-hypopnoea index, after treatment with a very low energy diet (-58%) were largely maintained after one year (-47%). Patients who lost the most weight or had severe sleep apnoea at baseline benefited most from the one year weight loss programme.

WHAT IS KNOWN AND WHAT THIS PAPER ADDS

Though randomised controlled trials have recently shown that weight loss improves obstructive sleep apnoea in overweight and obese patients, the long term effects of weight loss have been studied only in those with mild obstructive sleep apnoea and in older patients with type 2 diabetes. This study shows that obese men with moderate and severe sleep apnoea experienced similar beneficial effects of weight loss after one year.

Participants

63 obese men aged 30-65 with a body mass index (BMI) 30-40 and moderate to severe obstructive sleep apnoea (apnoea-hypopnoea index ≥15 events/hour) treated with continuous positive airway pressure.

Design and duration

Prospective observational one year follow-up study in a cohort derived from a randomised controlled trial, consisting of an initial nine week very low energy diet period followed by a weight loss maintenance programme.

MEAN (SD) CHANGES FROM BASELINE IN ANTHROPOMETRY AND SLEEP VARIABLES IN 63 OBESE MEN WITH MODERATE TO SEVERE SLEEP APNOEA (BASELINE OBSERVATION CARRIED FORWARD FOR MISSING DATA)

	After very low energy diet (change 0-9 weeks)	Maintenance period (change 9-52 weeks)	After full programme (change 0-52 weeks)	
Apnoea-hypopnoea index (events/hour)	15 (9)	-	19 (14)	
Change	-21 (16)*	4 (12)†	-17 (16)*	
Weight (kg)	95.4 (1.7)	-	101.0 (14.6)	
Change	-17.7 (6.7)*	5.6 (7.6)	-12.1(9.0)*	
Body mass index (BMI)	29.3 (2.9)	-	31.1 (3.6)	
Change	-5.5 (2.0)*	1.8 (2.3)	-3.7 (2.7)*	
Waist circumference (cm)	103.8 (9.5)	-	107.0 (11.1)	
Change	-16.0 (6.6)*	3.2 (8.2)‡	-12.8 (8.5)*	
*P<0.001, †P=0.007, ‡P=0.003, from paired samples <i>t</i> tests.				

Main outcome measure

Apnoea-hypopnoea index, the main index for severity of obstructive sleep apnoea.

Main results and the role of chance

Of 63 eligible patients, 58 completed the very low energy diet period and started the weight maintenance programme, with 44 completing the full programme, and 49 with complete measurements at one year. Data from all patients were analysed (baseline carried forward for missing data). At baseline the mean apnoea-hypopnoea index was 36 events/hour. After the very low energy diet period, the index was improved by -21 events/hour and weight by -18 kg (both P<0.001). After one year the apnoea-hypopnoea index was improved by -17 events/ hour and weight by -12 kg compared with baseline (both P<0.001). After one year patients with severe obstructive sleep apnoea at baseline had greater improvements in apnoea-hypopnoea index (-25 events/hour) compared with patients with moderate disease (-7 events/hour, P<0.001). After one year, 48% (30/63) no longer required continuous positive airway pressure during sleep and 10% (6/63) had achieved full remission (apnoea-hypopnoea index <5 events/hour). There was a dose-response association between weight loss and apnoea-hypopnoea index at follow-up (=0.50 events/kg, P=0.013).

Bias, confounding, and other reasons for caution

The main limitation is the observational study design. Our analysis is therefore limited by the lack of comparison with the apnoea-hypopnoea index in a control group with stable weight.

Generalisability to other populations

These findings were derived from middle aged obese men with moderate and severe obstructive sleep apnoea. Further studies are therefore needed to evaluate if weight loss by a very low energy diet has the same effect in women and in other age groups.

Study funding/potential competing interests

This study was partly supported by research grants from Cambridge Weight Plan, Northants, UK, and Novo Nordisk AS, Bagsværd, Denmark. KJ, SR, and EH have received travel grants from Cambridge Weight Plan to attend a scientific meeting.

Trial registration number

Current Controlled Trials No 70090382.

bmj.com/video

• Continuous positive airway pressure, obstructive sleep apnoea, and hypertension control This is a summary of a paper that was published on bmj.com as *BMJ* 2011;342:d2786

bmj.com/videos

• Alexander technique and massage for chronic and recurrent back pain

EDITORIAL by Fairbank

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Surgery with disc prosthesis versus rehabilitation in patients with low back pain and degenerative disc: two year follow-up of randomised study

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STUDY QUESTION

Is surgery with disc prosthesis as effective as rehabilitation for patients with chronic low back pain and degenerative discs?

SUMMARY ANSWER

Patients undergoing disc prosthesis improved more in the primary outcome (disability and pain) than patients treated with rehabilitation, but this improvement did not clearly exceed the prespecified minimal clinically important difference.

WHAT IS KNOWN AND WHAT THIS PAPER ADDS

Fusion and disc prosthesis have similar clinical outcomes. In this study outcome was better after surgery with disc prosthesis than rehabilitation, although both groups improved and surgery has additional risks.

Design

Randomised trial (in blocks) and computer generated allocation. Rehabilitation comprised a cognitive approach and supervised physical exercise for 12-15 days. Surgery comprised replacement of the intervertebral lumbar disc(s) with an artificial lumbar disc (ProDisc II).

Participants and setting

Eligible patients (n=173) were aged 25-55, had low back pain for at least a year, scored at least 30 on the Oswestry disability index, and had degenerative disc changes in L4/L5 or L5/S1, or both.

MEAN (SD) VALUES FOR PRIMARY AND SECONDARY OUTCOMES IN PATIENTS WITH LOW BACK PAIN AND DEGENERATIVE DISC RANDOMISED TO DISC PROSTHESIS SURGERY OR REHABILITATION

	Surgery	Rehabilitation	Treatment effect (95% CI)	P value		
Oswestry disability index (lower scores=less severe symptoms)						
Baseline	41.8 (9.1)	42.8 (9.3)	-	-		
1 year	22.3 (17.0)	33.0 (16.6)	-10.0 (-15.0 to -5.0)	<0.001		
2 years	21.2 (17.1)	30.0 (16.0)	-8.4 (-13.2 to -3.6)	0.001		
Low back pain (0=no pain)						
Baseline	64.9 (15.3)	73.6 (13.9)	-			
1 year	35.6 (28.6)	53.2 (28.4)	-14.0 (-23.0 to -5.0)	0.003		
2 years	35.4 (29.1)	49.7 (28.4)	-12.2 (-21.3 to -3.1)	0.009		
SF-36 physical component summary (higher scores=better health status)						
Baseline	30.5 (7.1)	30.8 (6.5)	-	-		
1 year	42.8 (12.2)	37.3 (11.0)	5.5 (1.9 to 9.1)	0.003		
2 years	43.3 (11.7)	37.7 (10.1)	5.8 (2.5 to 9.1)	0.001		
SF-36 mental component summary (higher scores=better health status)						
Baseline	47.7 (13.0)	45.2 (13.2)	-	-		
1 year	50.2 (12.0)	49.2 (13.2)	0.2 (-3.5 to 3.8)	0.90		
2 years	50.7 (11.6)	48.6 (12.8)	1.0 (-2.4 to 4.4)	0.50		

Primary outcome

The primary outcome measure was disability and pain measured by the Oswestry disability index one and two years after intervention.

Main results and the role of chance

The mean change from baseline to two year follow-up was 20.8 (95% confidence interval 16.4 to 25.2) in the surgery group and 12.4 (8.5 to 16.3) in the rehabilitation group. The mean treatment effect (difference between groups) at two year follow-up was 8.4 (-3.6 to 13.2) in the intention to treat analysis. Some 70% (n=51) of the patients in the surgery group and 47% (n=31) in the rehabilitation group had an improvement in their Oswestry score of at least 15 points (P<0.006). The number needed to treat was 4.4 (2.6 to 14.5). In the surgery and rehabilitation groups, 31% (n=21) and 23% (n=15) had returned to work (P=0.30) and 63% (n=46) and 39% (n=26) were satisfied with the outcome (P=0.005) at two years and 90% (n=66) and 73% (n=48) were satisfied with care (P=0.011) at one year.

Harms

Six patients (8%) had complications from surgery resulting in impairment at two years, and the reoperation rate was 7% (n=5). One patient had a serious complication, which resulted in a lower leg amputation.

Bias, confounding, and other reasons for caution

The study lacked a placebo or sham group, and patients in the rehabilitation group possibly found themselves faced with "more of the same." Further regression to the mean and the natural resolution of chronic low back pain must be considered. In comparisons of non-operative and operative treatment, there is probably a difference in placebo effect difficult to untangle from the treatment effect. The difference in compliance between groups and the high drop-out rate (surgery 15% (n=13), rehabilitation 24% (n=21)) could also have influenced the results.

Generalisability to other populations

Patients included in the study were highly selected, with one or two level degenerative changes and good general health.

Study funding/potential competing interests

The study was funded by the South Eastern Norway Regional Health Authority and the Norwegian Foundation for Health and Rehabilitation, through the Norwegian Back Pain Association.

Trial registration number

www.clinicaltrial.gov NCT 00394732.

EDITORIAL by McCarthy

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Sciences Centre, Toronto

Association between waiting times and short term mortality and hospital admission after departure from emergency department: population based cohort study from Ontario, Canada

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STUDY QUESTION

Are patients who present to emergency departments during shifts with long waiting times, and are not admitted, at risk of adverse events?

SUMMARY ANSWER

Patients presenting to an emergency department at a time when similar patients were experiencing long mean waiting times were at significantly increased risk of death or admission to hospital within seven days. Patients who leave without being seen are not at increased risk of adverse events compared with those who are seen and discharged.

WHAT IS KNOWN AND WHAT THIS PAPER ADDS

Long waiting times in emergency departments are a widespread problem and known to be associated with delays in care and poor outcomes for very sick patients. This study shows that waiting times can be an important patient safety issue among the most prevalent patients—those who go home after their visit.

Participants and setting

All patients in high volume emergency departments in Ontario, Canada, fiscal years 2003-7.

Design, size, and duration

Retrospective cohort study of 13 934 542 patients who were seen and discharged and 617 011 who left without being seen, using population based health administrative data. Conditional logistic multivariable regression modelled the risk of overall shift waiting times adjusted for acuity and status as a patient who left without being seen, on the outcomes of seven day mortality or need for admission.

Main results and the role of chance

The overall rate of death and admission within seven days grant

was 0.07% and 1.8%, respectively. The risk of adverse events increased with mean length of stay of similar patients in an emergency department. For mean length of stay of ≥ 6 versus <1 hour, the adjusted odds ratios were 1.79 (95% confidence interval 1.24 to 2.59) for death and 1.95 (1.79 to 2.13) for admission in high acuity patients and 1.71 (1.25 to 2.35) for death and 1.66 (1.56 to 1.76) for admission in low acuity patients. Leaving without being seen was not associated with an increase in adverse events.

Bias, confounding, and other reasons for caution

As an observational study it is possible the association between waiting times and adverse events was subject to unmeasured confounding. Although we have shown that the relation between adverse events and waiting times exists within, as well as between, emergency departments, there could be local factors at play during shifts with long waiting times, such as differences in staffing, that could be unmeasured drivers of adverse events.

Generalisability to other populations

Findings should be generalisable to similar healthcare systems. The rate of use of emergency departments in Ontario is comparable with that in other jurisdictions, suggesting a similar case mix, although other countries have reported higher rates of patients leaving without being seen. Findings might not be generalisable in health systems with lower hospital bed occupancies and lower thresholds for admission or in health systems with barriers to access for follow-up care.

Study funding/potential competing interests

This study was supported by a grant from the Ontario Ministry of Health and Long Term Care and by the Institute for Clinical Evaluative Sciences, which is funded by an annual grant from the Ministry of Health and Long Term Care.

MEAN SHIFT LENGTH OF STAY IN EMERGENCY DEPARTMENT AND SEVEN DAY MORTALITY AND ADMISSION BY PATIENT ACUITY*

	Adjusted odds ratio† (95% CI) for mortality		Adjusted odds ratio† (95% CI) for admission	
Length of stay (hours)	High acuity	Low acuity	High acuity	Low acuity
<1 (reference)	1.00	1.00	1.00	1.00
1-<2	1.37 (0.95 to 1.97)	1.28 (1.05 to 1.56)	1.38 (1.27 to 1.51)	1.13 (1.10 to 1.18)
2-<3	1.42 (0.99 to 2.04)	1.42 (1.14 to 1.75)	1.59 (1.46 to 1.73)	1.28 (1.23 to 1.33)
3-<4	1.49 (1.04 to 2.15)	1.42 (1.12 to 1.79)	1.72 (1.58 to 1.88)	1.40 (1.35 to 1.46)
4-<5	1.51 (1.05 to 2.17)	1.68 (1.30 to 2.17)	1.80 (1.64 to 1.96)	1.48 (1.41 to 1.55)
5-<6	1.63 (1.13 to 2.35)	1.71 (1.27 to 2.31)	1.86 (1.70 to 2.03)	1.58 (1.49 to 1.67)
≥6	1.79 (1.24 to 2.59)	1.71 (1.25 to 2.35)	1.95 (1.79 to 2.13)	1.66 (1.56 to 1.76)

*According to Canadian triage and acuity scale (1-3=high acuity; 4-5=low acuity).

†Adjusted for leaving without being seen, triage level, calendar month, age group, sex, income fifth, urban/rural community, No of emergency department visits to department in previous year, chief complaint, and time/day of shift.