



Eating During the Night: Three Studies Examining Meal Timing and Food Choice Across Two Industries

Siobhan Banks PhD

Brain and Body at Work
University of South Australia

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University of
South Australia

Brain and Body at Work
Research Group



24/7 workplace demands on human health

- Circadian misalignment and short, disrupted sleep
- Increased risk for negative health outcomes including metabolic disease



Inappropriate timing of meals has a major impact on metabolism

- Habitually eating during the night is problematic due to slower gastric emptying, and reduced glucose tolerance and insulin sensitivity Goo et al 1987; Van Cauter et al 1992; Morgan et al 1999
- These changes cause a reduction in glucose tolerance to meals eaten during the night (laboratory and field trials) Al-Naimi et al 2004; Morgan et al 2012; Hampton et al 1996; Morgan et al 1998; Lund et al 2001
- Eating the main meal late in the day has also been shown to reduce the effectiveness of weight loss programs independent of energy intake, dietary composition or sleep duration Garaulet et al 2013
- Meals consumed after 22:00h predict BMI even after controlling for sleep timing and duration Baron et al 2011



Shift work is associated with altered food patterns and diet quality



↑ Changes in timing and frequency



↓ Reduced diet quality

Shift work is associated with altered food patterns and diet quality

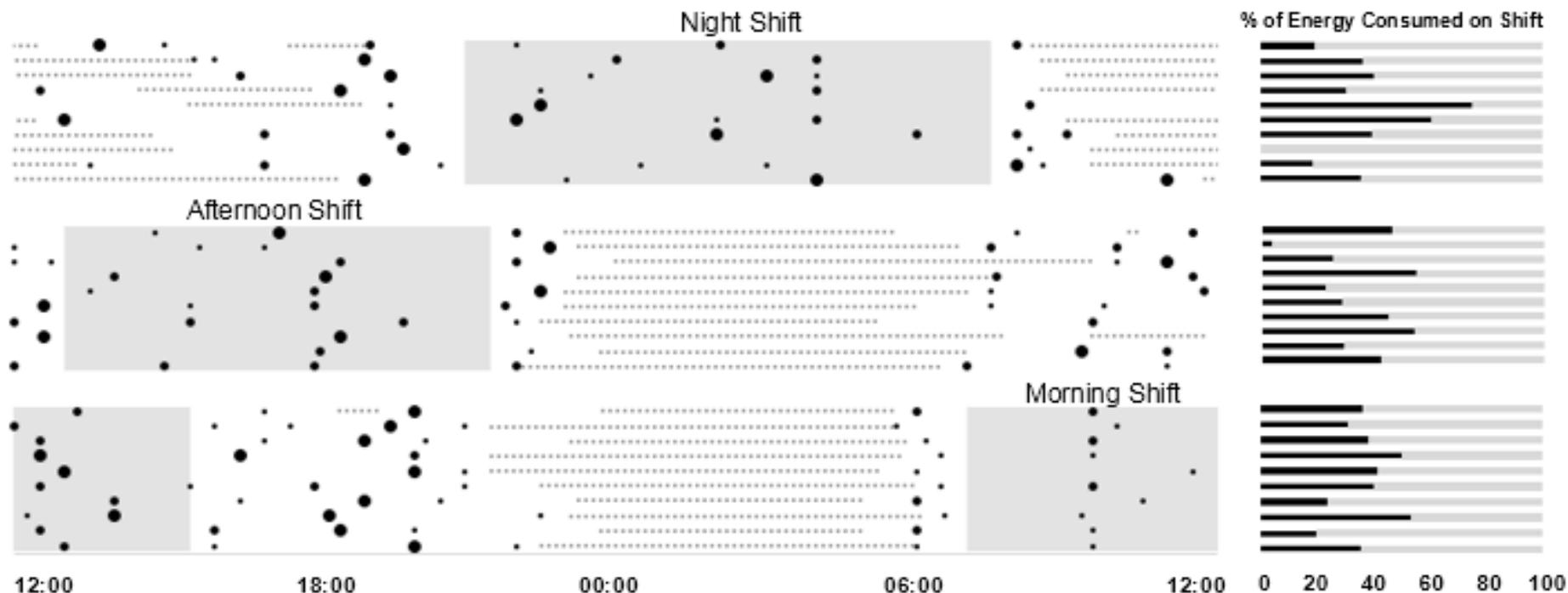


**Study in nurses
examining changes in
meal timing and
frequency**



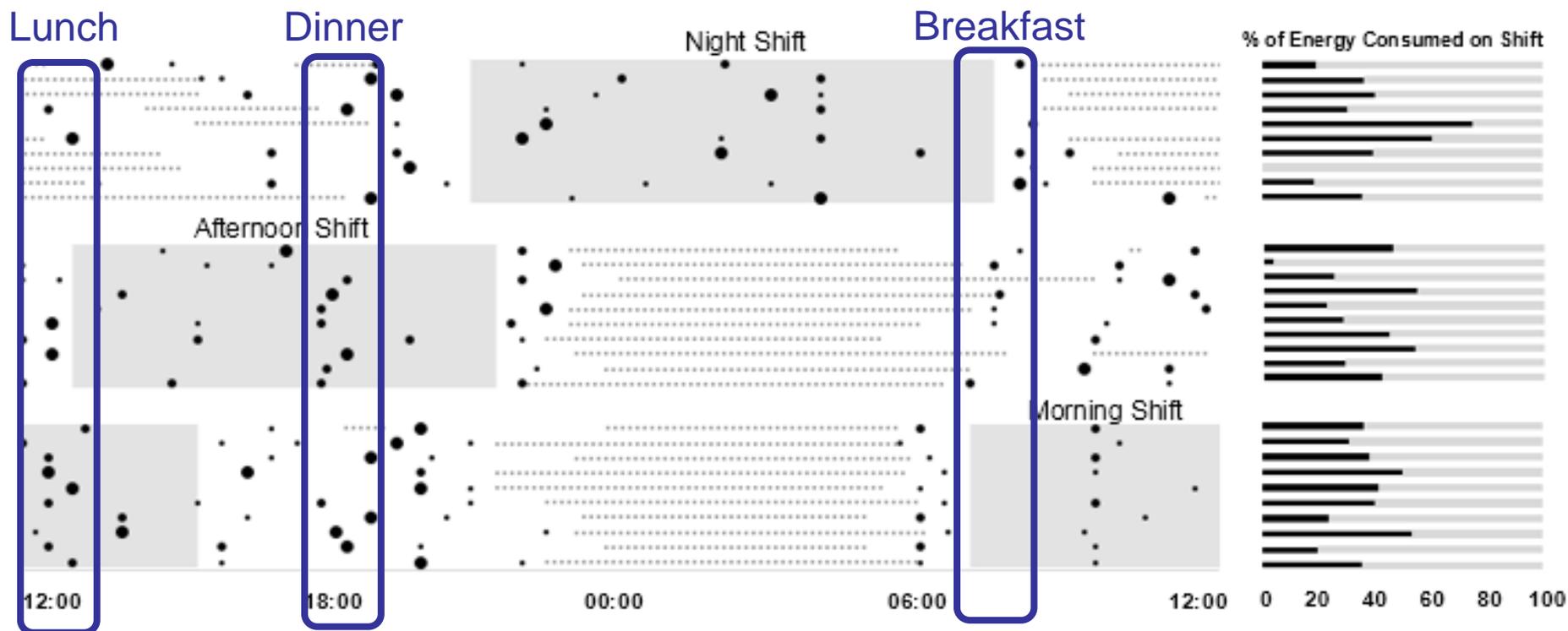
**↓ Reduced
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Shiftwork changes eating patterns



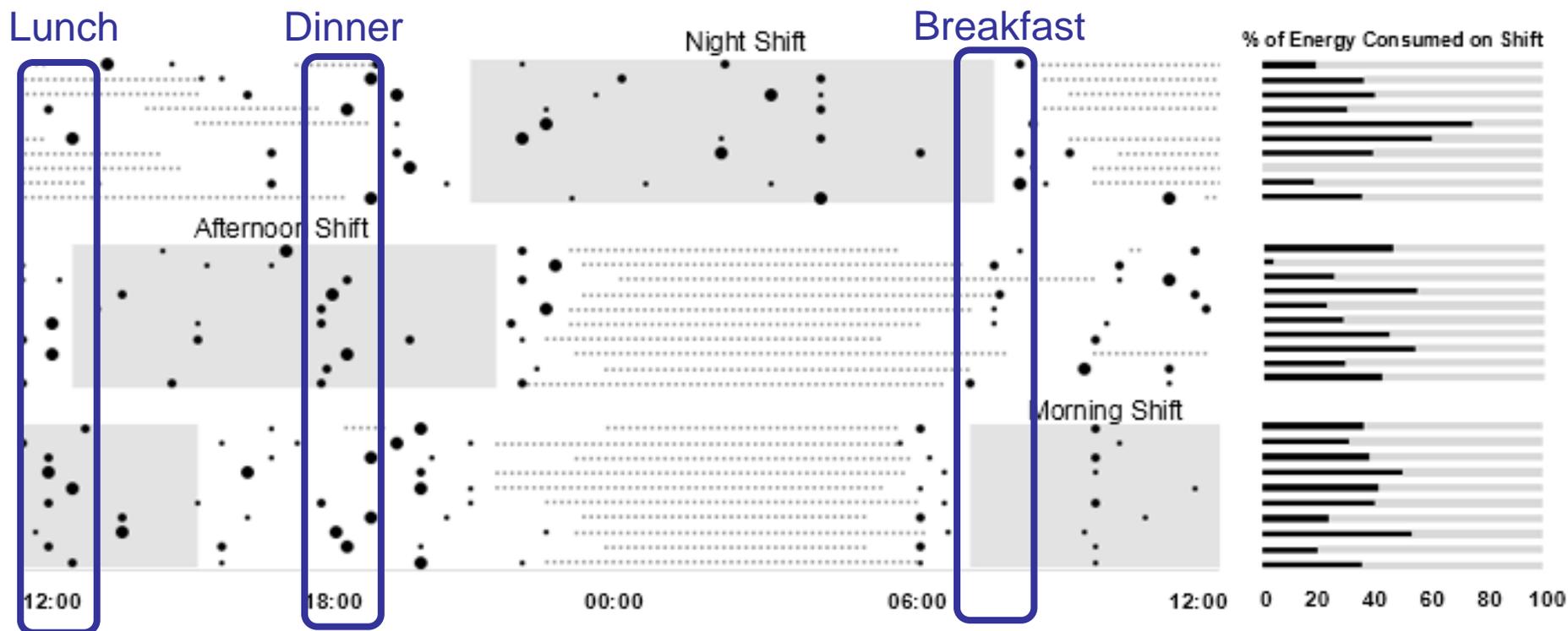
- Participants (n=11) worked a mix of shift types and each line represents a 24 h pattern for an individual.
- Shift times are shaded in grey, free-living is white. Grey dotted lines show sleep periods. Meal size is reflected by size of dot. Right column displays the proportion of daily energy consumed while on shift.
- On average workers on night shift ate 30% of their total daily calories at night.
- Substantial consistency for on-shift consumption of food across repeated night shifts (ICC=0.72)

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BMI higher among those workers eating a meal late in the night (29.6 ± 7.8) compared to those with other patterns (25.6 ± 4.2)

Shift work is associated with altered food patterns and diet quality



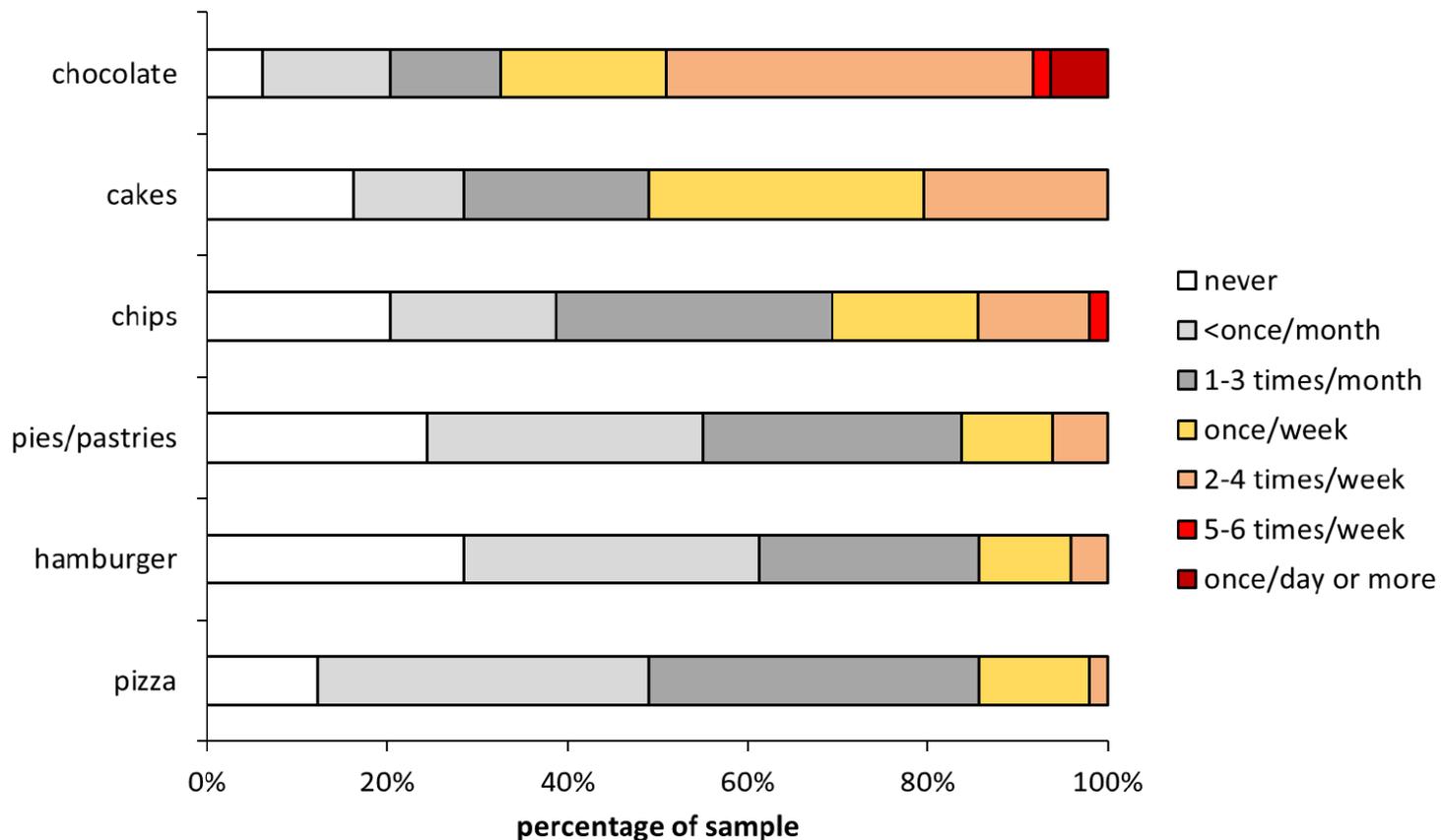
↑ Changes in timing and frequency



Field studies in nurses (N=50/22) and flight attendants (N=32) to examine meal quality and motivations for eating while working shifts

High consumption of indulgence foods while working night shift

Frequency of Consuming "Indulgence" Foods



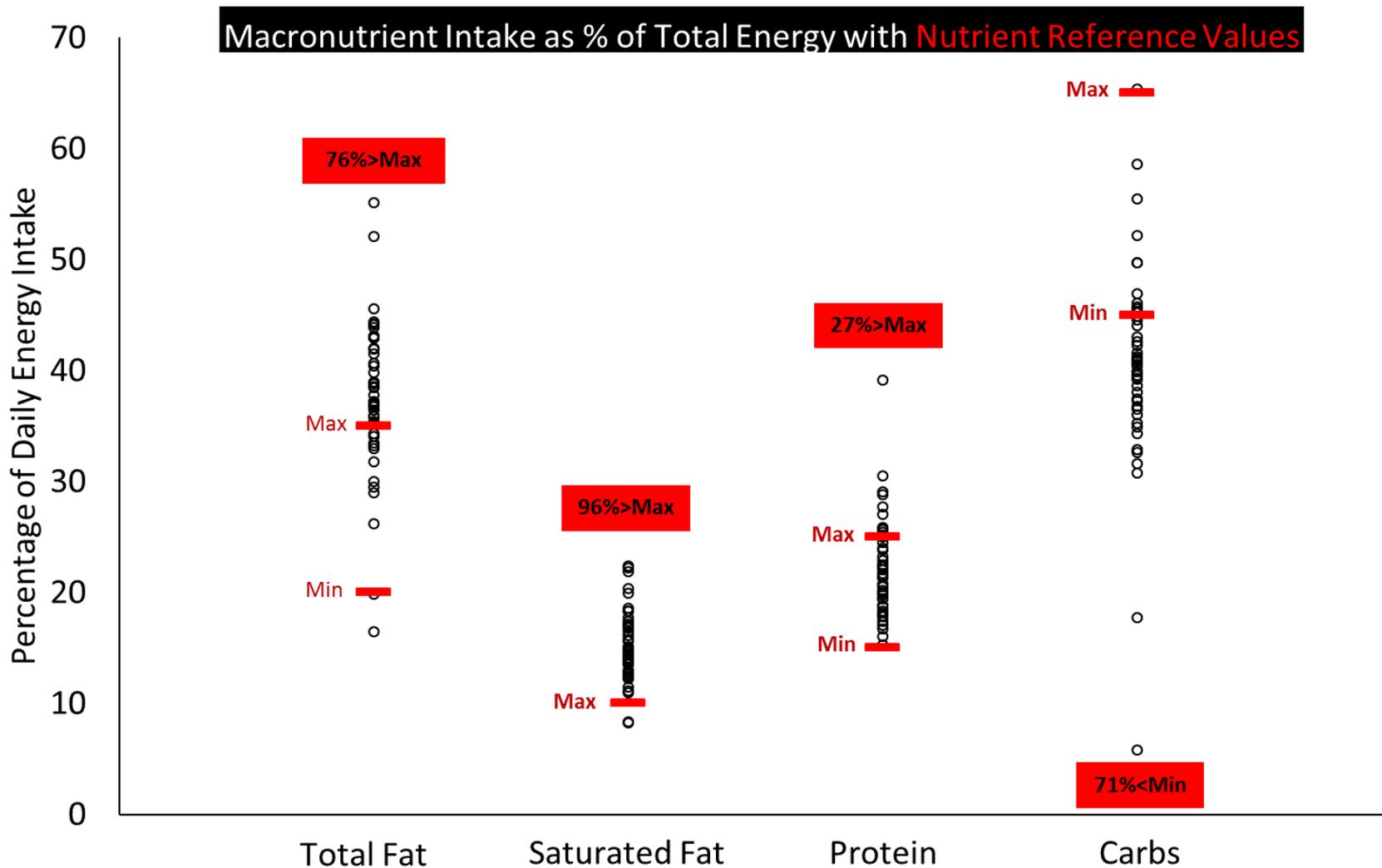
6.3% had chocolate at least once per day

47.1% had chocolate more than twice per week

20% had cake more than twice per week

14.3% had chips more than twice per week

Higher than recommended fat intake, including saturated fat





Nurses eat at night for many reasons

(quotes from interviews)

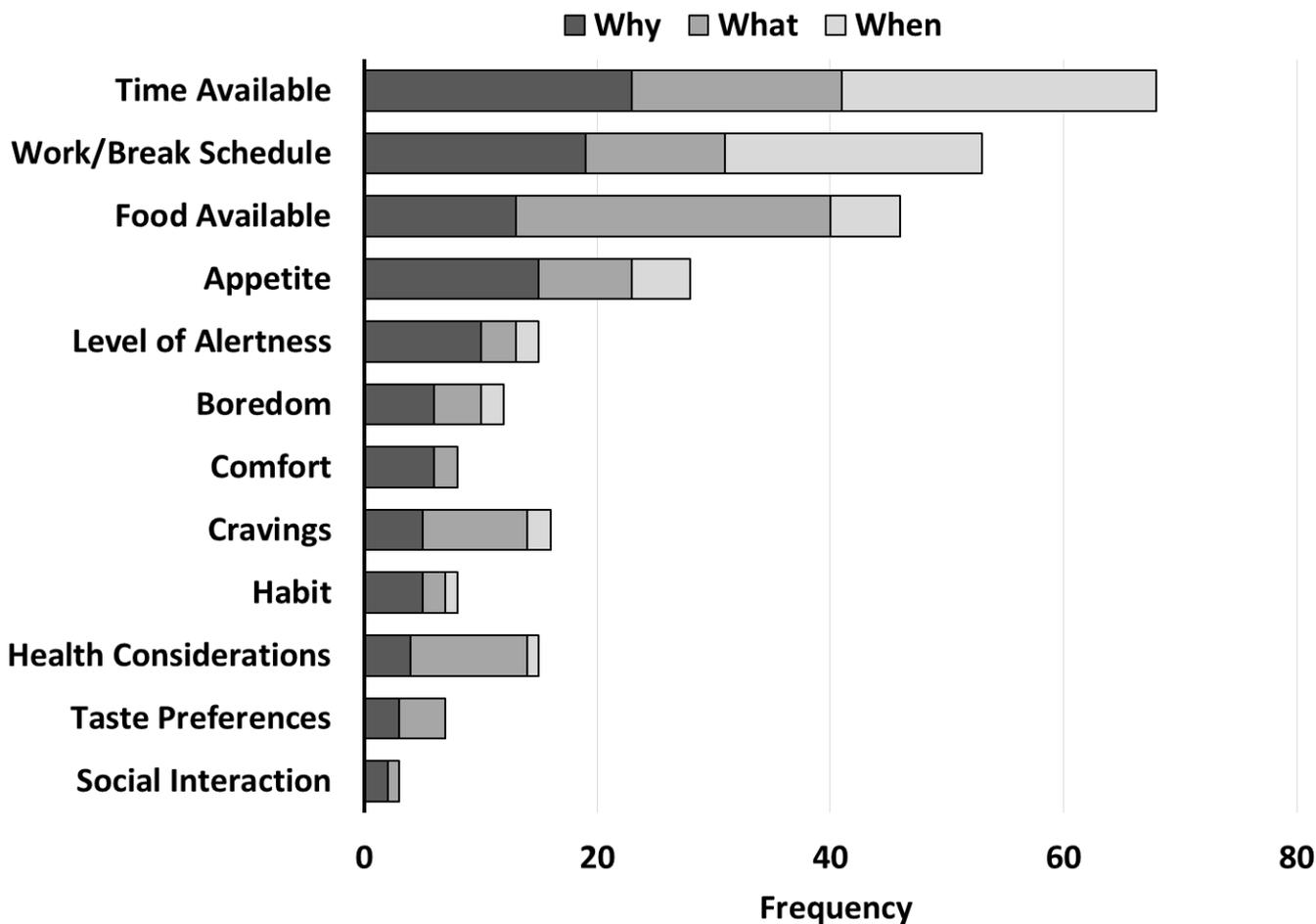
Food as a reward:

- *“You have to have some sort of a reward so people bring in cheese and dips and chocolates and biscuits.” #4206RA*
- *“I’ll go down to the vending machine and get a chocolate bar, like if it’s been a hard night.” #3103CO*

Social influences:

- *“If there was pizza or if someone brought in lollies and stuff, I’d probably be stuffing my face.” “CCC: So, Chips, Coke and Chocolate” #3207ST*
- *“Some of the staff bring in bags of chips and everybody shares...But I’m not really hungry, I’m just eating it because I’m tired and it’s there.” #4704ER*
- *“night shift is chip eating central. I don’t usually bring stuff in because I don’t want to eat it and then people bring it in.” #3611WE*
- *“It could be fruit, it could be cheese and biscuits, it could be lollies, it could be anything we just end up with a big mix, a buffet.” 4611JA*

However motivation to eat and what foods are consumed is workplace specific

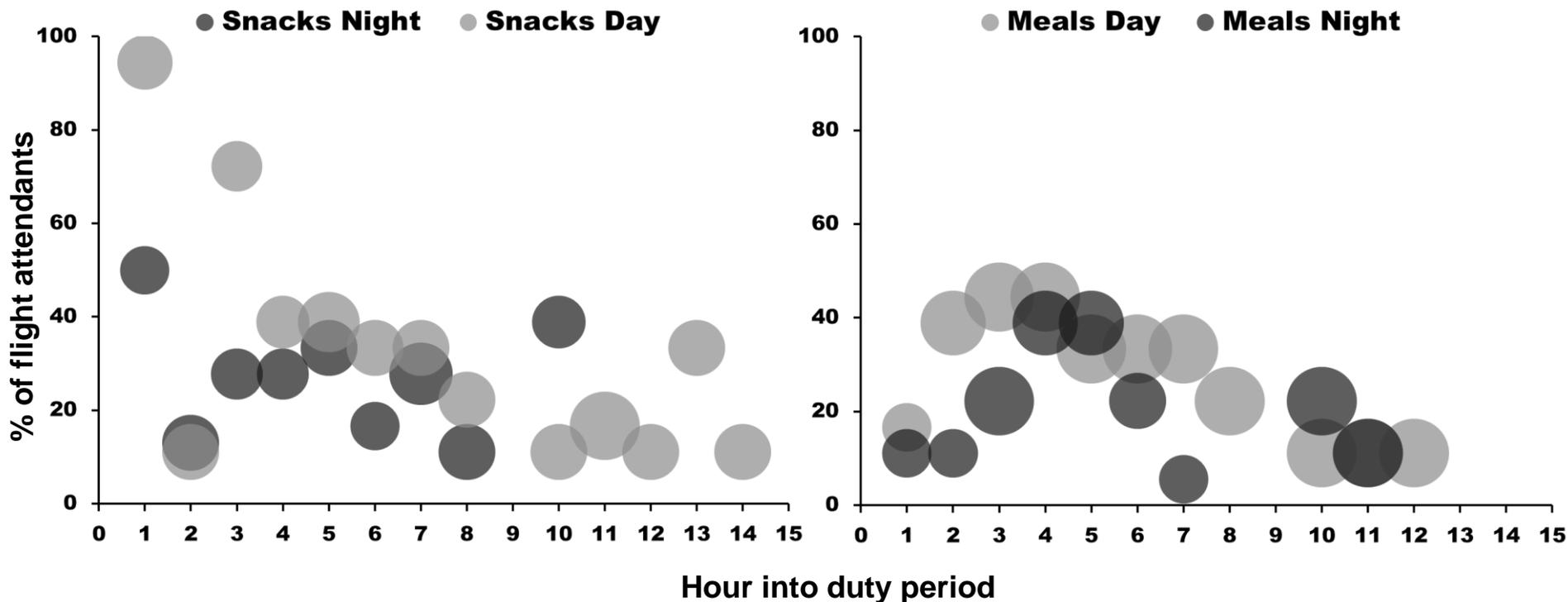


- 32 Australian FAs
- Completed online questionnaire about eating on shift
- FAs average length of duty was 12.1 ± 2.7 h and length of flight was 11.1 ± 3.3 h
- why, what and when FAs ate while on shift was primarily determined by work constraints
- Limited types of food available
- Very specific worktime/break structure

- Only 22% of the sample said they ate because of *appetite*.

Flight attendant meal and snack consumption on day and night duty periods

Size of dot = amount of food consumed, e.g. larger the dot the more food consumed



- More snacks ($p=0.03$) and meals ($p=0.01$) consumed early in the duty period vs late
- Night meal consumption primarily determined by work schedule



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Sleep Research



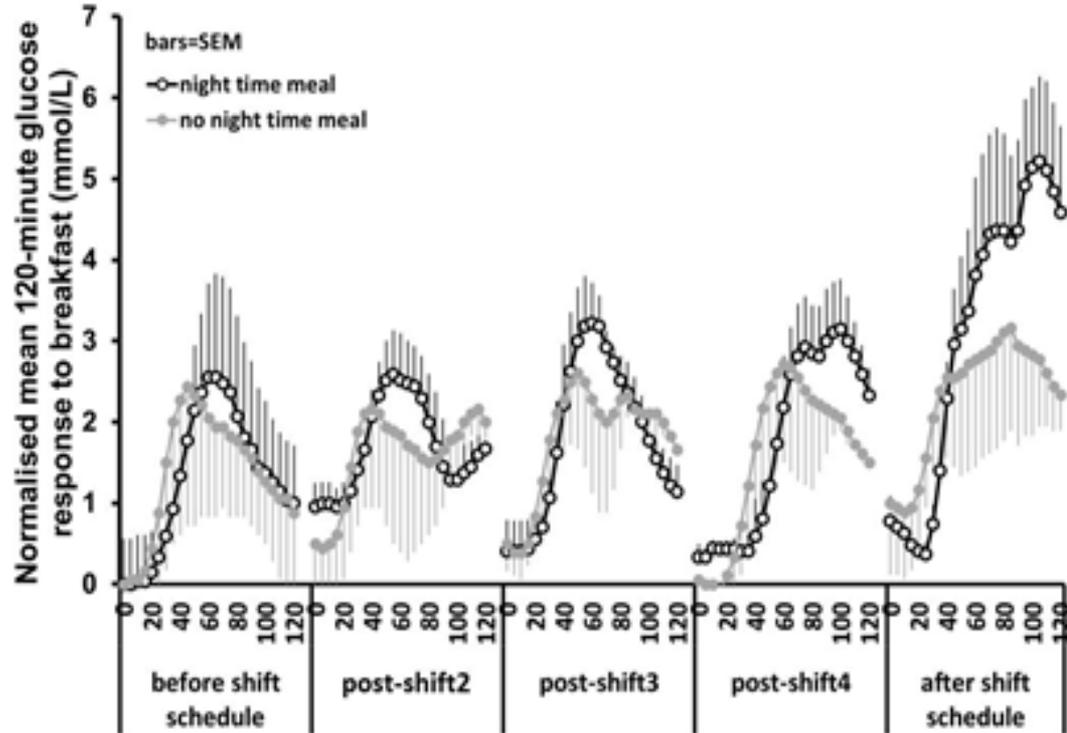
Changing meal timing to improve metabolic health?

- Animal studies have shown that many of the metabolic deficits associated with simulated shift work are reversed if food intake is withheld during the 'shift', when they would normally be asleep (eg Barclay et al. *PloS one*. 2012; Salgado-Delgado R et al. *Endocrinology*. 2010)
- Even when fed a high-fat diet during off-shift periods mice weighed significantly less than mice fed during 'night shifts' Arble DM et al. *Obesity*. 2009
- This suggests that meal timing could be a potent intervention for avoiding and treating shift work associated metabolic disorders
- **Could altered meal timing alone, as a dietary intervention, improve glucose metabolism to reduce chronic disease risk in shift workers?**
 - Proof of concept study
 - N=12 Healthy Males, BMI 20-28 kg/m², Age 25.7±5.6
 - Eating at night group vs no eating at night during 4 simulated night shifts
 - Only altered meal times; meals contained identical 24h energy, macronutrient content, glucose load
 - Tested: metabolic response to a standard breakfast using continuous glucose monitoring and plasma glucose and insulin at -15, 0, 15, 30, 60, 90, 120 min post-breakfast



Metabolic effects of simulated shift work are reduced by not eating at night

Continuous glucose monitoring: response to breakfast



- Glucose metabolism was impaired, cumulatively across days, and was sustained even after return to the normal schedule when participants ate at night.
- Not eating at night reduced the accumulation of glucose impairment across days.

Conclusions

- Shift workers change their eating patterns/timing and meal quality
- Eating at night has consequences for metabolism and could increase the risk of developing chronic obesity-related disease outcomes
- Not eating at night lessens the impact of shift work on glucose metabolism
 - Eating earlier at night? Snacks? Quality of food?
- Changes to timing of meals could be readily translated to reduce the significant and increasing burden of metabolic disease
- But each workplace has unique constraints. Need for tailored countermeasures for both the individual and workplace

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Brittany James
Isla Reid-Dicks
Paige Knott
Sally Turra

Research Assistants:

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Michael Cvirn
Oscar Weng
Nicholas Croucher
Samantha Windler
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