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Psychosocial determinants of diurnal alpha-amylase among healthy Quebec workers

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ABSTRACT

Salivary alpha-amylase (sAA) is a stress-sensitive biomarker the shows promise as an indirect proxy of sympathetic-adrenal-medullary axis activities that are otherwise difficult to discern non-invasively. This comprehensive study investigated diurnal sAA in association with numerous psychosocial characteristics related to mental health, work stress, and non-work stress. Participants included 395 workers (56.1% women, age: $M = 41.3$, SD = 10.81) from across 34 distinct workplaces. Diurnal sAA was sampled over two non-consecutive work days at awakening, 30 min after awakening, 14h00, 16h00, and bedtime. Well-validated psychometrics and survey items were used to measure mental health (psychological distress, depression, burnout, work characteristics) (task design, demands, social relations, gratifications), and non-work characteristics (marital/parental status, economic statuses, marital and parental stress, work-family conflicts). Preliminary results revealed that men showed occasionally higher sAA concentrations than women. Multilevel regressions were used to analyze sAA concentrations nested according to levels (i) for each time-point, (ii) between workers, and (iii) across workplaces while covarying for time of awakening, sex, age, cigarette smoking, alcohol consumption, regular physical activity, psychotropic drug use, and body mass index. Main results revealed that psychological demands, support from colleagues, interpersonal conflicts, job recognition and job insecurity appear to be associated with diurnal sAA, while non-work factors did not. Our findings showing a distinct diurnal profile for sAA replicate and expand those of Nater et al. (2007, Psychoneuroendocrinology 32, 392–401), providing further evidence that sAA is associated to subjective psychosocial factors.

1. Introduction

Biomarkers related to psychosocial stress provide insights into the pathophysiological correlates of diverse human conditions. To date, the biomedical literature on stress-sensitive biomarkers secreted into circulation have centered on (1) the *hypothalamic-pituitary-adrenal* (HPA)-axis production of the stress hormone cortisol, (2) the *sympathetic-adrenal-medullary* (SAM)-axis release of catecholamines like adrenaline, and (3) the immune system mobilization of pro- and anti-inflammatory cytokines like interleukin-6 (Nater et al., 2013). Technological advances that led to the biochemical assessment of cortisol via saliva (Kirschbaum and Hellhammer, 1994) promoted non-invasive sampling methods that have revolutionized our understanding of the stress-disease link. By contrast, the SAM-axis and immune systems are still bound to extraction from urine and/or blood, making their incorporation into field studies less feasible. However, salivary alpha-amylase (sAA) has been found to be a proxy of SAM-axis activities (Rohleder et al., 2004) and shows promise as a stress-sensitive biomarker of health.

Alpha-amylase is a primary salivary protein involved in mucosal immune functioning by inhibition of bacteria (Scannapieco, 1994). sAA release is neurologically controlled by acinar cells that are innervated by both the sympathetic and the parasympathetic branches of the autonomic nervous system (Emmelin, 1987). This makes sAA a prime candidate to approximate SAM-axis activities that are unreliably assessed in saliva. Indeed, salivary catecholamine concentrations are several times lower than those obtained from blood, and so do not reflect the acute changes in SAM-axis activities (Kennedy et al., 2001). A growing number of studies reveal that sAA profiles are sensitive to stress exposure (Rohleder et al., 2004; Nater et al., 2005; Nater et al., 2006). Critically, sAA correlates with SAM-axis release of noradrenaline

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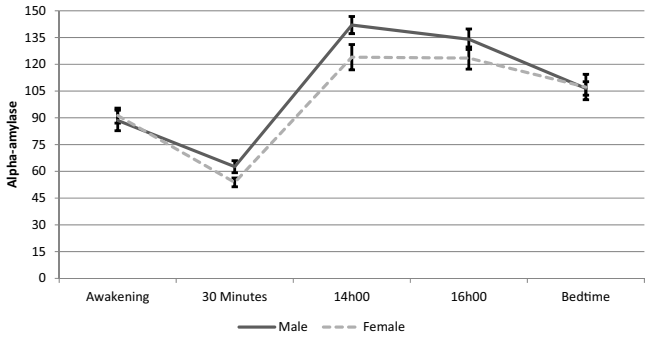

Fig. 1. Mean (SE) diurnal salivary alpha amylase (U/ml) as a function of sex.

(Thoma et al., 2012), suggesting that sAA is indeed a proxy of adrenergic activities.

Diurnal variation of stress biomarkers can be assessed non-invasively via saliva. Salivary flow rate and saliva composition vary according to 24-h circadian rhythms (Dawes, 1974). Early studies showed that sAA displays low concentrations in the morning and high values in the afternoon (Ferguson et al., 1973). In the first comprehensive assessment of diurnal determinants of sAA, Nater et al. (2007) asked healthy German university students ($N = 76$) to sample saliva 15 times over the course of single day. Their data confirmed that sAA has a distinct diurnal profile characterized by a pronounced decrease 60-min after awakening and a steady increase of activity thereafter (Nater et al., 2007). Using diary information on momentary stress, mood, food, or physical activity, they further showed that diurnal sAA appears to be relatively independent of self-reported perceived stress and salivary cortisol, but is associated with chronic stress, positive moods, and to age differences (Nater et al., 2007). In the spirit of replication and expansion, this latter finding requires further exploration in a larger and older sample.

Psychiatric research has also endeavoured to identify whether sAA might be useful in the context of psychiatric illnesses like major depressive disorder (MDD). In a case-controlled assessment of afternoon sAA (12h00–16h00), sAA was higher among Japanese individuals with unremitted MDD ($n = 28$) compared to remitted MDD ($n = 43$) and healthy controls ($n = 103$) (Ishitobi et al., 2010). Likewise in another Japanese assessment of afternoon sAA (13h00–17h00), concentrations were higher among female MDD patients ($n = 88$) than healthy controls ($n = 41$) prior to an electrical stimulation task (Tanaka et al., 2012). A Polish study showed that depressed individual also show higher morning sAA (8h20–9h00) than age and sex matched controls (Cubala and Landowski, 2014). In a large Dutch cohort study (Veen et al., 2013), MDD patients showed a gradient trend for the highest evening sAA concentrations (22h00 and 23h00) among current MDD ($n = 752$) followed by remitted MDD patients ($n = 611$) and lastly healthy controls ($n = 329$). Recent studies have also endeavoured to link sAA to stress reactivity habituation in panic disorder patients (Petrowski et al., 2015). In sum, psychiatric conditions appear to be associated with elevated diurnal sAA; however, it is unclear whether sAA is associated with other psychiatric symptoms.

Occupational health psychology has also endeavoured to understand how work stress relates to sAA. In a German study of 215 nurses from different hospitals (Wingenfeld et al., 2010), diurnal sAA was collected at four time-points (7h00, 11h30, 17h30, and 20h00). While female nurses showed more pronounced increases in sAA over the day, psychiatric symptoms related to depression, anxiety, work stress, and burnout were not related to sAA. Among Japanese nurses ($N = 25$) from one hospital who provided samples 12 times over 6 days, morning and evening sAA was higher among night shifts than day shifts (Morita et al., 2014).

The effect of shift work is also important in further understanding diurnal sAA. A study of Canadian paramedics ($N = 21$) assessed five time-points (+30 min after awakening, 6h00, 12h00, 18h00, and bedtime) on two work days and one rest day (Wong et al., 2012). Dispatchers showed lower daily sAA production than ambulance paramedics, while rotating shift-workers exhibited a flatter sAA diurnal slope than daytime-only workers. Despite mixed directionality, these findings suggest that diurnal sAA is related to workplace stress in non-clinical populations. However, other important workplace stressors have been omitted by sAA studies. For example, stressors associated with task design (skill utilization, decision authority), demands (physical, psychological, contractual), social relations (social support, interpersonal conflicts, harassment), and gratifications (job recognition, career perspective, job insecurity) have been routinely linked to mental health symptoms (Marchand et al., 2015). Yet, whether these factors relate to sAA are, to the best of our knowledge, unknown.

Psychosocial contexts outside of the workplace are also related to sAA. For example, the stress and strain of caregiving (Savla et al., 2013), interparental aggression (Gordis et al., 2010), and acculturation (Snodgrass et al., 2012) are related to distinct diurnal patterns of sAA. This may suggest that the pervasive effects of adversity can be captured using measures of sAA. Notwithstanding, other non-work factors that are important in the stress-disease literature have often been neglected in sAA studies. These include factors like marital status, parenting, socioeconomic status, strained marital and parental relationships as well as social support outside the workplace. These stressors have also been routinely related to problems associated with psychological distress, depression, and burnout (Marchand et al., 2015).

Overall, previous sAA studies exhibit some limitations that the current study endeavours to compliment. Psychoneuroendocrine studies of sAA generally have small sample sizes, varying sampling designs, and diverse protocols that make comparisons difficult in light of the multi-directional findings reported in this growing literature. In the context of workplace stress, studies that include workers generally focus on specific employment types (e.g., nurses, teachers, managers) within specific companies that ultimately limit generalizability both nationally and internationally. Given the vast individual differences in psychosocial contexts, it is also essential that sAA be investigated while controlling for numerous factors related to health behaviors, mental health, as well as work and non-work characteristics.

In the current comprehensive study, we examined diurnal variations in sAA concentrations over the course of two work-days in a sample of 395 workers from across 34 distinct workplaces. Our research objectives were to evaluate how sub-clinical psychiatric symptoms (e.g., psychological distress, depression, burnout),