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Aspects of the parent–child relationship and parent metabolic outcomes

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Abstract Much is known about the effect of parent–child relationships on child health; less is known about how parent–child relationships influence parent health. To assess the association between aspects of the parent–child relationship and parent metabolic outcomes, and whether these associations are moderated by parent gender. Five metabolic outcomes (systolic and diastolic blood pressure, heart rate, total cholesterol and glycated hemoglobin) were assessed among 261 parents (45.83 ± 5.50 years) of an adolescent child (14.57 ± 1.072 years). Parents completed questionnaires assessing their child's hassles and the quality of their days with their child. Parents' perceptions of their child's hassles were associated with parent heart rate (B = 2.954, SE = 1.267, $p = 0.021$) and cholesterol (B = 0.028, SE = 0.011, $p = 0.010$), such that greater perceived child hassles were associated with higher heart rate and cholesterol levels, on average. These associations were not moderated by parent gender (all $ps > 0.30$). Parent report of their day with their child was not associated with parent metabolic outcomes (all $ps > 0.20$). Parent gender moderated the association between parent report of their day with their child and parent systolic blood pressure (B = 13.861, SE = 6.200, $p = 0.026$), such that less positive reports were associated with higher blood pressure readings among fathers, but not mothers. This study suggests that parent metabolic health may in part be influenced by aspects of the parent–child relationship.

Keywords Parent–child relationship · Interpersonal relationships · Metabolic outcomes · Parents · Adolescents · Perceived hassles

Introduction

Nearly half of the US population lives with one or more chronic diseases and cardiovascular disease remains the primary cause of mortality in the country (Ward, Schiller, & Goodman, 2014). Considerable attention has been given to identifying early risk and protective factors that may affect the development of cardiovascular disease and other chronic diseases, such as health behaviors (e.g., smoking, exercise) and environmental factors (e.g., socioeconomic status, access to fresh foods, pollution; Mozaffarian et al., 2015). However, psychosocial factors, such as social relationships, can also clearly affect physical health across the lifespan (Pietromonaco & Collins, 2017; Robles, Slatcher, Trombello, & McGinn, 2014; Uchino, 2006; Uchino, Cacioppo, & Kiecolt-Glaser, 1996; Yang et al., 2016), and may spillover into these other domains. Close relationships can be socially rewarding, enhance positive affect, and buffer against cardiovascular reactivity to psychological stressors (Cohen, 2004; Pietromonaco & Collins, 2017; Uchino et al., 1996). Conversely, in a recent review by Pietromonaco and Collins (2017), persistent dysfunction and discord within close relationships can contribute to emotional distress (Cohen, 2004; Pietromonaco & Collins, 2017), which has been associated with elevated blood pressure and increased heart rate (DeLongis, Folkman, &

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Lazarus, 1988; Robles et al., 2014), increased susceptibility to infection (Cohen et al., 1998), and immune dysregulation (Jaremka et al., 2013; Robles et al., 2014).

One interpersonal relationship that has received considerable attention in health research is that between a parent and child. It is one of the most important relationships for both parents and children across their respective lifespans (Steinberg, 2005; Umberson & Montez, 2010), and may shape psychological (Ackard, Neumark-Sztainer, Story, & Perry, 2006; Repetti, Taylor, & Seeman, 2002) and physiological health trajectories (Repetti et al., 2002; Schofield, Conger, Gonzales, & Merrick, 2016). Similar to other close relationships, the parent–child relationship is bidirectional (Pietromonaco, Uchino, & Dunkel Schetter, 2013) and involves complex processes and transactions that influence, and are influenced by, numerous contextual factors (Uchino et al., 1996; Walsh, 2012). Extensive attention has been given to child health outcomes resulting from this familial relationship (Repetti et al., 2002; Schofield et al., 2016), yet there is limited research on *parent* health outcomes. For example, one study found that parents higher in empathy had greater levels of inflammation compared to less empathic parents (Manczak, DeLongis, & Chen, 2016) and another study found that parents from families marked by more conflict and less warmth exhibited a more proinflammatory phenotype compared to parents from families reporting less conflict and more warmth (Robles et al., 2018). Aside from these studies, however, most research on parent health outcomes has focused on assessing parents of children with developmental needs (Foody, James, & Leader, 2015) or chronic illness diagnoses (Kuster & Merkle, 2004). These parents may be exposed to frequent caregiving stressors and the health outcomes for these parents may not generalize to all parents. Hence, consideration of more typical aspects of parent–child relationships that may contribute to parent health outcomes is needed, particularly regarding metabolic health outcomes as previous studies have focused largely on immune outcomes (e.g., Manczak et al., 2016; Robles et al., 2018). Identification of aspects of the parent–child relationship that affect parent metabolic health may have the potential to inform preventative efforts to promote both the health of parents and families in general, seeing as adults' health may affect their parenting roles as well.

Parent physiological health may in part be influenced by parents' perceptions of their child's daily hassles (Hartos & Power, 1997), with hassles being any tasks, demands, or difficulties their children face. Children may experience a variety of hassles each day, ranging from tasks at school (e.g., exams) or at home (e.g., chores) to navigating demands from family members or friends. These hassles may not only affect adolescents, but also their parents, who are invested in their well-being. Several studies have demonstrated the interdependence of individuals in close, familial relationships, such that actions and emotions of one individual in a dyad are associated with psychological and physiological reactions in the partner (Pietromonaco et al., 2013; Slatcher, Robles, Repetti, & Fellows, 2010). For example, Uchino and colleagues found that the level of ambivalence of one spouse was associated with the level of coronary-artery calcification in the other partner (Uchino, Smith, & Berg, 2014) and that the quality of one partner's social network was correlated with the ambulatory blood pressure of his or her partner (Uchino, Smith, Carlisle, Birmingham, & Light, 2013). Within the parent–child relationship specifically, adult children's ambivalence has been associated with poorer self-reported physical health for mothers (Fingerman, Pitzer, Lefkowitz, Birditt, & Mroczek, 2008). Although ambivalence may fall under the broader umbrella of dyadic relationship issues, more individual issues for children have also been shown to affect parents' health. For example, the frequency of adolescents' diabetes management concerns has been associated with greater variability in fathers' affect (Queen, Butner, Wiebe, & Berg, 2016) and emotion dysregulation in adolescent children has been linked to increased physiological dysregulation, specifically respiratory sinus arrhythmia, in parents of female youth with depression (Crowell et al., 2014). Considering previous research on the interrelatedness of dyads, particularly the effect of children's behaviors and characteristics on their parents' health, it is possible that children's daily hassles, as perceived by their parents, may spillover and affect parents' physical health.

Parent physiological health may be further affected by the perceived *quality* of daily life with their child. There has been extensive research on the quality of daily interpersonal interactions more generally on individual health outcomes (Repetti et al., 2002; Slatcher & Selcuk, 2017; Umberson & Montez, 2010). Broadly speaking, positively perceived interactions with others have been linked to reduced cortisol stress reactivity in healthy young adults (Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007) and attenuated cardiovascular reactivity in healthy middle-aged adults (Steptoe, Lundwall, & Cropley, 2000). Conversely, interactions appraised as primarily negative have been associated with increased risk for coronary heart disease in adults (Smith & Ruiz, 2002) and greater likelihood for developing hypertension, albeit only for adult women (Sneed & Cohen, 2014). Specific to interactions between parents and children, Lee, Zarit, Rovine, Birditt, and Fingerman (2016) found that higher quality interactions between parents and their adult children was linked to increased marital satisfaction for fathers, but not mothers. Although this study provided evidence of the quality of interactions on parents socially, the effect of these interactions on parent physical health is unknown.

In addition to balancing multiple roles (Almeida, 2005; Crouter, Bumpus, Head, & McHale, 2001), parents of adolescents may be particularly vulnerable to adverse metabolic outcomes because they generally have less leisure time (Lam, McHale, & Crouter, 2012) and experience more conflict with their children compared to parents of younger children (McGue, Elkins, Walden, & Iacono, 2005). Research also suggests that these daily altercations may affect parents more so than their children (Steinberg, 2005). Although existing research on the relationship between parents and their adolescent children generally focuses on conflict, other aspects of this relationship should also be considered and may affect parents. For example, the physiological effects associated with the quality of daily interpersonal interactions, along with the increased likelihood of parent-adolescent altercations and fewer opportunities for joint leisure activities, suggest that parents' day-to-day life with their children is relevant to parents' physiological well-being and metabolic functioning.

The extent to which parents are physiologically affected by parent–child relationships may also vary by parent gender. Mothers report more distressing exchanges with their adolescent children in comparison to fathers (Steinberg, 2005) as well as experiencing more general interpersonal distress each day (Almeida & Kessler, 1998). Considering mothers may experience negative interactions more frequently than fathers, adverse physiological consequences may be observed only in women. Gender differences research, most of which focuses on marital relationships, includes mixed findings for interpersonal relationships and their effects on physiological outcomes (see reviews by Kiecolt-Glaser & Newton, 2001 and Robles et al., 2014). Marital quality has been found to be associated with mortality (Hibbard & Pope, 1993) work disability (Appelberg, Romanov, Heikkila, Honkasalo, & Koskenvuo, 1996), and self-reported health (Levenson, Carstensen, & Gottman, 1993) for women, but not men. Additionally, the frequency of negative interactions with a spouse was more strongly associated with hypertension in women, but not men (Sneed & Cohen, 2014). Conversely, some studies failed to find gender differences (Fisher, Nakell, Terry, & Ransom, 1992; Ganong & Coleman, 1991), whereas some studies on attachment (Powers, Pietromonaco, Gunlicks, & Sayer, 2006), social roles (Schreier, Hoffer, & Chen, 2016), and social support (Seeman, Singer, Ryff, Dienberg Love, & Levy-Storms, 2002) have suggested more pronounced physiological effects among men. Considering these divergent findings, it is unclear whether fathers or mothers may be more or less susceptible physiologically to perceptions of their child's daily hassles and the quality of daily life with their child.

The current study aimed to address the relatively unexplored associations between aspects of the parent-adolescent relationship and parent metabolic functioning. First, we investigated the association between parent perceptions of their child's daily hassles and parent metabolic functioning. In line with previous research (Crowell et al., 2014; Fingerman et al., 2008; Queen et al., 2016; Uchino et al., 2014, 2013), we hypothesized that parents who perceived greater daily hassles for their child would have more adverse metabolic outcomes. Second, we considered the association between parent reports of the quality of their days with their child and parent metabolic functioning. Also in accordance with previous research on the quality of social interactions (Eisenberger et al., 2007; Slatcher & Selcuk, 2017; Steptoe et al., 2000; Uchino, 2006; Umberson & Montez, 2010), it was hypothesized that parents who report having had more negative days with their child would have more adverse metabolic outcomes. Third, we assessed the potential moderating effect of parent gender on these associations; this was largely exploratory given the mixed findings on physiological outcomes and gender differences in the literature.

Methods

Participants

The participants for this study were 261 parents (one parent per family; mean age of 45.83 ± 5.50 years; 23.8% fathers) who were the primary caregivers for an adolescent child between the ages of 13 and 16 (mean age of 14.57 ± 1.072 years). Parents were recruited from the greater Vancouver, BC, area between January 2010 and March 2012. Parents needed to be fluent in English and have no chronic illness diagnoses. Of those who participated in the study, 60.2% identified as being of European descent, 32.2% as Asian descent and 7.7% identified as another ethnicity; participants came from a range of socioeconomic backgrounds. Participant information is provided in Table 1.

Procedure

Parents attended afternoon appointments with their child, who was participating in other parts of the study. After providing written consent, parents provided demographic information through interviews with trained research assistants who then collected peripheral blood samples via antecubital venipuncture for assessment of total cholesterol and glycated hemoglobin. Systolic blood pressure, diastolic blood pressure, and heart rate were assessed using an automatic blood pressure monitor. Parents also reported on aspects of the parent–child relationship each evening over a typical two-week period. This study was conducted

Table 1 Sample descriptives

N = 261	n (%)	M (SD)
Parent gender		
Male	62 (23.8)	
Female	199 (76.2)	
Age (years)		45.83 (5.50)
Ethnicity		
European	157 (60.2)	
Asian	84 (32.2)	
Other	20 (7.7)	
Total family income		
< $5,000	4 (1.5)	
$5,000–$19,999	12 (4.6)	
$20,000–$34,999	21 (8.0)	
$35,000–$49,999	34 (13.0)	
$50,000–$74,999	59 (22.6)	
$75,000–$99,999	36 (13.8)	
$100,000–$149,999	52 (19.9)	
$150,000–$199,999	28 (10.7)	
> $200,000	13 (5.0)	
Marital status		
Married/living with a partner	177 (72.0)	
Single	25 (10.2)	
Divorced/separated	43 (17.5)	
Widowed	1 (0.4)	
Parent BMI		25.21 (4.51)
Child gender		
Male	117 (47.6)	
Female	129 (52.4)	
Perceived daily hassles for their child		0.78 (0.53)
Parent report of day with child		2.69 (0.29)
Mean daily parent stress		0.53 (0.37)
Mean time spent with child (hours)		3.36 (2.75)
Metabolic markers		
Systolic blood pressure, mmHg		110.46 (11.85)
Diastolic blood pressure, mmHg		72.09 (9.24)
Heart rate, bpm		68.12 (10.52)
Glycated hemoglobin, mmol/mol		5.406 (0.354)
Total cholesterol, mg/dL		4.841 (1.06)

Reported means and standard deviations for glycated hemoglobin and total cholesterol are reflective of raw scores. Values for glycated hemoglobin and total cholesterol were log transformed for subsequent analyses. Perceived daily hassles for their child were averaged over 14 days of parents' reports of these hassles on a 4-point scale ranging from 0 ("no hassles") to 3 ("hassles in all domains"). Parent reports of their days with their child were averaged over 14 days on a scale ranging from 1 ("negative") to 3 ("positive"). Mothers and fathers did not differ with respect to the main predictor variables or covariates (all ps > 0.10.)

through the University of British Columbia and the university's research ethics board approved the study.

Measures

Parent perceptions of child daily hassles

Parents reported on their perceptions of their child's daily hassles over a two-week period by indicating whether their child experienced any hassles at home (e.g., chores), school (e.g., class assignments, multiple exams) and/or related to issues with family members (e.g., disagreements) or friends (e.g., disagreements, peer pressure). For each of the four categories, parents indicated "yes" if their child experienced any hassles in that domain or "no" if their child did not. "Yes" responses were coded as 1, "no" responses as 0. The responses were summed to determine that day's score for child hassles, with a possible range of 0 (indicating no hassles) to 4 (indicating hassles across all domains). These daily totals were then averaged across the number of days completed to create a summary score of child daily hassles (mean rating = 0.78 ± 0.53), providing an indication of parents' general perceptions of child daily hassles over a typical two-week period. Completion rates for the daily surveys were high, with most parents completing 12 or more of the 14 surveys (mean of 12.69 ± 2.87 surveys). Specifically, 84% of parents completed 12 or more surveys, with 71% of parents completing surveys on all 14 days. Data from daily surveys were averaged across all completed days.

Parent report of the quality of their day with their child

At the same time, parents reported on the quality of their day with their child every evening by completing the following item: "*overall, my day with my child was___*" (1 = negative; 2 = neutral; 3 = positive). Again, to gain insight into family life in general and because there was limited variability in parents' answers over the two-week period, parents' responses over the number of days they completed were averaged (mean rating = 2.69 ± 0.29).

Metabolic markers

Parents were asked to sit quietly for 10 min before blood pressure and heart rate were measured. Following this acclimation period, three measures of heart rate, systolic, and diastolic blood pressure were taken via a VSM-100 BpTRU (BpTRU Medical Devices; Coquitlam, British Columbia) automatic blood pressure monitor and an occluding cuff which was placed on the participant's non-dominant arm. After a 5-min resting period, measures were taken every 2 min over a 6-min period to mitigate fluctuations in blood pressure and heart rate resulting from acclimation to the laboratory setting. The first readings were discarded and the average score for systolic blood pressure, diastolic blood pressure, and heart rate was calculated by taking the mean of the subsequent three readings, respectively. Although more variable than resting blood pressure, a higher resting heart rate has been associated with increased risk for cardiovascular disease in healthy adult samples, independent of other recognized risk factors (Cooney et al., 2010; Fox et al., 2007; Kristal-Boneh, Silber, Harari, & Froom, 2000).

Peripheral blood was drawn into serum separator tubes (SSTs; Becton–Dickinson, Franklin Lakes, NJ) to assess total cholesterol. SSTs were centrifuged for 10 min at 1200 rcf 60 and 120 min post-blood collection; plasma was stored at -30° C until analysis. Total cholesterol was assessed using a Hitachi 911 device (Kyowa Medex, Japan) at St. Paul Hospital (Vancouver, British Columbia). Elevated total cholesterol levels have been linked to increased risk for cardiovascular disease (Ridker, Rifai, Cook, Bradwin, & Buring, 2005). To determine glycated hemoglobin, peripheral blood was drawn into EDTA-containing Vacutainer tubes (Becton–Dickinson, Oakville, Ontario, Canada), which were stored at 4° C and assayed within a 12-h period. Glycated hemoglobin levels were determined via a liquid chromatography technique (Bio-Rad Laboratories Inc., Hercules, California). Assays reflect the percentage of glycated hemoglobin. The detection for the lower range was 1.2%; the interassay coefficient of variation was 1.2%. Glycated hemoglobin is used to determine a person's average blood glucose concentration over a three-month period and is highly correlated with fasting glucose levels. Elevated levels of glycated hemoglobin are linked to an increased risk for Type II diabetes and cardiovascular disease (Selvin et al., 2010).

Covariates

Parents provided sociodemographic information, including their gender, ethnicity, age, income, and marital status, as well as the gender of their child, who was participating in the study. Parents' body mass index (BMI) was also included as a covariate and was calculated by taking parents' weight in kilograms (measured using a medical scale after participants had removed shoes and outerwear) and dividing it by their height in meters squared.

In addition to these covariates, parents' own perceived stress levels were considered in analyses to control for the potential influence of parents' own stress levels on their perceptions of their child's daily hassles, ratings of their days with their child, and physiological outcomes. In previous studies, parents' perceptions of their own stress have been associated with changes in parenting characteristics and family interactions (Crnic & Greenberg, 1990) and greater perceived stress has been linked to worse health outcomes (Brosschot, Gerin, & Thayer, 2006). Parents reported on their own stress levels over the same two-week period during which they reported on their relationship with their child. They were asked to report whether they experienced any of six potentially stressful situations each day, including issues relating to role overload (4 items; e.g., too much work at home) and daily hassles (2 items; e.g., problems with transportation). The number of endorsed items were summed each day and averaged across the 14-day period to create a mean parent daily stress score (mean = 0.53 ± 0.37). Finally, average time per day spent with their child was calculated based on parents' daily reports of the number of hours they spent with their child (mean = 3.36 ± 2.75 h) and included as a covariate. The amount of time parents spend with their child may affect the extent to which they are aware of their child's hassles and how much they are affected by their relationship with their child.

Analyses

Cholesterol and glycated hemoglobin were not normally distributed and were each log transformed to reduce positive skew. Parent and child gender were coded as 0 = male and 1 = female. Given the relative group sizes for ethnic and racial groups in this sample (see Table 1) as well as potential cultural differences in parenting, dummy variables were created to compare parents who identified as being of either Asian or "Other" ethnic/racial descent to parents of European descent. Income was determined by the annual total gross family income in Canadian dollars across 9 income levels ranging from "less than $5,000" to "$200,000 and higher." Given both the sample distribution (see Table 1) and potentially qualitatively different experiences of parents with a certain marital status, dummy variables were created to compare parents who were either single or divorced/separated/widowed to those who were married/living with a partner. Only one person reported being widowed and was included in the divorced/separated category. Average scores across the two-week daily diary period were considered for parents' perceptions of their child's daily hassles, the quality of their days with their child, and their own perceived stress levels, respectively, in an effort to capture the nature of typical family life cross-sectionally rather than changes from day to day. Prior to fitting the multiple regression models, a correlation matrix (see Table 2) was estimated for all independent variables, dependent variables and covariates. Consistent with prior studies (Gavish, Ben-Dov, & Bursztyn, 2008), systolic and diastolic blood pressure were highly correlated ($r(260) = 0.794$). However, they were examined in separate models as per recommendations outlined by the

Table 2 Correlation matrix of main study variables

	1	2	3	4	5	6	7	8	9
1. Perceived hassles for child	1								
2. Avg. day with child	−0.063	1							
3. Parent age	0.013	0.001	1						
4. Family income	−0.046	−0.018	0.168*	1					
5. Asian descent	0.134†	−0.054	−0.043	−0.046	1				
6. Other descent	−0.033	0.001	−0.172*	−0.116	−0.193*	1			
7. Parent gender	−0.021	0.059	−.163†	0.099	−0.001	−0.025	1		
8. Child gender	0.115	−0.092	−0.029	−0.180*	−0.025	0.049	0.094	1	
9. Single	0.023	0.063	−0.185*	−0.283*	−0.174*	0.060	0.094	0.159*	1
10. Div./widowed/separated	0.070	−0.042	0.010	−0.264*	−0.071	0.113	0.063	0.105	−0.157*
11. Daily parent stress	0.267*	−0.074	−0.085	−0.045	0.039	0.101	0.077	0.028	−0.087
12. Time spent with child	−0.011	0.196*	−0.213*	−0.028	0.069	0.141†	0.123	0.115	0.159†
13. BMI, kg/m^2	0.025	−0.037	0.021	0.037	−0.152†	0.055	−0.235*	−0.002	0.069
14. SBP, mmHg	−0.109	−0.009	0.101	.136†	0.049	−0.088	−0.316*	−0.147†	−0.069
15. DBP, mmHg	−0.032	−0.003	0.076	0.080	0.097	−0.112	−0.237*	−0.116	−0.068
16. Heart rate, bpm	0.151†	−0.036	−0.048	0.082	0.174*	−0.120	−0.023	−0.065	−0.193*
17. Cholesterol, mg/dL	0.127†	0.095	0.182*	−0.018	−0.033	0.038	−0.172*	−0.070	−0.053
18. HbA1c, mmol/mol	0.034	−0.019	0.210*	0.059	0.124	−0.029	−0.093	−0.034	−0.031

	10	11	12	13	14	15	16	17	18
1. Perceived hassles for child									
2. Avg. day with child									
3. Parent age									
4. Family income									
5. Asian descent									
6. Other descent									
7. Parent gender									
8. Child gender									
9. Single									
10. Div./widowed/separated	1								
11. Daily parent stress	0.182*	1							
12. Time spent with child	0.028	−0.061	1						
13. BMI, kg/m^2	−0.089	−0.044	−0.026	1					
14. SBP, mmHg	−0.075	−0.113	−0.006	0.367*	1				
15. DBP, mmHg	−0.058	−0.105	−0.042	0.197*	0.795*	1			
16. Heart rate, bpm	−0.052	−0.009	0.014	0.174*	0.100	0.197*	1		
17. Cholesterol, mg/dL	−0.001	−0.109	0.010	0.175*	0.235*	0.195*	0.099	1	
18. HbA1c, mmol/mol	−0.108	−0.060	−0.035	0.119	.159†	.164†	0.079	0.172*	1

†$p < 0.05$; *$p < 0.01$. Parent report of their days with their child = Avg. rating of parent report over the 14-day period (negative, neutral, positive); Daily parent stress = Avg. parent rating of his or her daily stress over a 14-day period; Time spent with child (hours) = Avg. parent report of time in hours spent each day with child over a 14-day period; Parent and child gender variables coded as 1 for female and 0 for male; Cholesterol and glycated hemoglobin values were log transformed

BMI body mass index, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *HbA1c* glycated hemoglobin

Prospective Studies Collaboration on the separate inclusion of both outcomes when assessing cardiovascular health (Lewington, Clarke, Qizilbash, Peto, & Collins, 2002). Correlations among all other variables were moderate to weak (all *r*s between |0.001| and |0.367|).

All multiple regression models controlled for parent age, income, ethnicity, gender, marital status, BMI, average parent stress, child gender, and average time per day spent with child. For interactions, all covariates and dependent variables were first centered (zeroed at their respective

Table 3 Multiple regression models of main effects of perceived hassles for child on parent metabolic outcomes

	Systolic blood pressure, mmHg			Diastolic blood pressure, mmHg			Heart rate, bpm			Cholesterol, mg/dL			Glycated hemoglobin, mmol/mol		
R^2 (Change in R^2)	R^2 = 0.260 (0.011)			R^2 = 0.123 (0.000)			R^2 = 0.148 (0.021)			R^2 = 0.119 (0.027)			R^2 = 0.092 (0.001)		
	B	β	SE	B	β	SE	B	β	SE	B	β	SE	B	β	SE
Intercept	89.235*		8.308	65.711*		7.018	61.319*		7.692	0.519*		0.066	0.660*		0.022
Age	0.019	0.009	0.137	−0.020	−0.011	0.116	−0.170	−0.089	0.127	.003†	0.162	0.001	0.001*	0.197	0.000
Income	1.071†	0.169	0.425	0.559	0.113	0.359	−0.000	0.000	0.393	−0.003	−0.063	0.003	0.001	0.048	0.001
Asian descent	3.177†	0.125	1.578	2.593	0.132	1.333	2.349	0.107	1.461	−0.008	−0.043	0.013	.010†	0.176	0.004
Other descent	−3.476	−0.076	2.786	−2.769	−0.078	2.354	−3.951	−0.100	2.580	0.027	0.081	0.022	0.004	0.039	0.007
Parent BMI	0.852*	0.325	0.158	.332†	0.163	0.134	0.482*	0.213	0.146	.003†	0.131	0.001	0.001	0.124	0.000
Parent gender	−7.079*	−0.257	1.709	−4.350*	−0.203	1.444	0.751	0.032	1.582	−0.017	−0.084	0.014	−0.002	−0.032	0.004
Child gender	−1.519	−0.064	1.412	−0.881	−0.048	1.193	−1.101	−0.054	1.307	−0.014	−0.079	0.011	0.000	0.002	0.004
Single	1.054	0.027	2.601	0.251	0.008	2.197	−7.824*	−0.231	2.408	−0.017	−0.057	0.021	0.004	0.045	0.007
Div./sep./wid.	1.764	0.057	1.977	1.028	0.043	1.670	−1.092	−0.041	1.831	−0.004	−0.017	0.016	−0.004	−0.050	0.005
Daily parent stress	−1.937	−0.061	1.962	−2.236	−0.090	1.658	−1.123	−0.041	1.817	−.032†	−0.137	0.016	−0.004	−0.052	0.005
Time with child (hours)	0.241	0.054	0.268	0.049	0.014	0.226	0.210	0.055	0.248	0.002	0.071	0.002	−0.000	−0.006	0.001
Perceived child hassles	−2.459	−0.109	1.368	−0.398	−0.023	1.156	2.954†	0.152	1.267	.028†	0.173	0.011	0.002	0.034	0.004

†$p < 0.05$; *$p < 0.01$; B = unstandardized beta; β = standardized beta; SE = standard error; Glycated hemoglobin and cholesterol were log transformed; Div./sep./wid./= divorced/separated/widowed dummy variable; Perceived hassles for child = Avg. perception of child's daily hassles over a 14- day period; Daily parent stress = Avg. parent rating of his or her own stress over a 14- day period; Time with child (hours) = Avg. parent report of time in hours spent each day with child over a 14- day period; Parent and child gender variables coded as 1 for female and 0 for male

means). Interaction variables were then created separately for parent gender x child daily hassles and parent gender x parent report of their days with their child. Separate main effect models, first for child daily hassles and then for parent report of their days with their child, were fit for parent metabolic outcomes. Then, the respective interactions for each aspect of the parent–child relationship and parent gender, were considered in separate models. All analyses were conducted using SPSS version 24.0 (IBM, New York, NY).

Results

Perception of child daily hassles and parent metabolic outcomes

Main effects of child daily hassles

Child daily hassles were significantly associated with parent heart rate (B = 2.954, SE = 1.267, $p = 0.021$) and total cholesterol (B = 0.028, SE = 0.011, $p = 0.010$); see Table 3. Greater child daily hassles were associated with higher heart rate and higher total cholesterol in parents, such that for every 1-unit increase in child daily hassles, parent heart rate increased by 2.954 beats per minute and parent total cholesterol increased by 0.028 mmol/L. The full main effect model explained 14.8% of the variance in heart rate and 11.9% of the variance in cholesterol within this sample of parents. Child daily hassles were not significantly associated with systolic blood pressure ($p > 0.07$), diastolic blood pressure ($p > 0.70$) or glycated hemoglobin ($p > 0.60$).

Moderation by parent gender

Parent gender did not moderate the association between child daily hassles and parent metabolic outcomes (all $ps > 0.30$), suggesting that the effect of child daily hassles on parent metabolic health did not significantly differ for mothers and fathers.

Table 4 Multiple regression models of moderation effects of parent gender on the association between parent report of their days with their child and parent metabolic outcomes

	Systolic blood pressure, mmHg			Diastolic blood pressure, mmHg			Heart rate, bpm		
R^2 (Change in R^2)	R^2 = 0.263 (0.016)			R^2 = 0.128 (0.004)			R^2 = 0.127 (0.001)		
	B	β	SE	B	β	SE	B	β	SE
Intercept	115.143*		1.748	74.813*		1.481	67.870*		1.633
Age	0.007	0.003	0.136	− 0.012	− 0.007	0.116	− 0.153	− 0.080	0.127
Income	.829†	0.131	0.420	0.402	0.082	0.356	− 0.063	− 0.012	0.392
Asian descent	3.201†	0.126	1.570	2.734†	0.138	1.330	2.867	0.131	1.467
Other descent	− 2.898	− 0.064	2.728	− 2.824	− 0.081	2.312	− 3.968	− 0.103	2.550
Parent BMI	0.838*	0.320	0.157	.336†	0.165	0.133	0.491*	0.218	0.146
Parent gender	-6.424*	− 0.232	1.708	− 4.063*	− 0.189	1.447	0.685	0.029	1.596
Child gender	− 1.809	− 0.077	1.408	− 1.073	− 0.058	1.193	− 0.901	− 0.044	1.315
Single	0.899	0.023	2.575	0.316	0.010	2.182	− 7.424*	− 0.219	2.406
Div./sep./wid.	1.430	0.046	1.962	0.921	0.038	1.662	− 1.061	− 0.040	1.833
Daily parent stress	− 2.582	− 0.081	1.885	− 2.174	− 0.087	1.597	0.093	0.003	1.761
Time with child (hours)	0.168	0.039	0.265	− 0.037	− 0.011	0.224	0.202	0.055	0.247
Parent report of day with child	− 24.945†	− 0.612	11.463	− 9.669	− 0.305	9.713	− 5.804	− 0.166	10.712
Parent report*Gender	13.861†	0.631	6.200	5.614	0.328	5.253	2.788	0.148	5.794

	Cholesterol, mg/dL			Glycated hemoglobin, mmol/mol		
R^2 (Change in R^2)	R^2 = 0.104 (0.004)			R^2 = 0.092 (0.004)		
	B	β	SE	B	β	SE
Intercept	0.694*		0.014	0.731*		0.005
Age	.003†	0.161	0.001	0.001*	0.213	0.000
Income	− 0.003	− 0.066	0.003	0.000	0.033	0.001
Asian descent	0.000	0.003	0.013	.009†	0.157	0.004
Other descent	0.021	0.062	0.022	0.004	0.035	0.007
Parent BMI	.003†	0.155	0.001	0.001	0.117	0.000
Parent gender	− 0.018	− 0.091	0.014	− 0.002	− 0.028	0.004
Child gender	− 0.009	− 0.052	0.011	− 0.001	− 0.012	0.004
Single	− 0.010	− 0.035	0.021	0.003	0.032	0.007
Div./sep./wid.	0.000	0.002	0.016	− 0.005	− 0.063	0.005
Daily parent stress	− 0.019	− 0.082	0.015	− 0.003	− 0.044	0.005
Time with child (hours)	0.001	0.036	0.002	0.000	0.002	0.001
Parent report of day with child	− 0.069	− 0.232	0.092	0.031	0.321	0.030
Parent report*Gender	0.053	0.326	0.050	− 0.018	− 0.340	0.016

† $p < 0.05$; * $p < 0.01$; *B* unstandardized beta, *β* standardized beta, *SE* standard error; Glycated hemoglobin and cholesterol were log transformed; Div./sep./wid./= divorced/separated/widowed dummy variable; Parent report of their days with their child = Avg. rating of parent report over the 14-day period (negative, neutral, positive); Daily parent stress = Avg. parent rating of his or her daily stress over a 14-day period; Time with child (hours) = Avg. parent report of time in hours spent each day with child over a 14-day period; Parent and child gender variables coded as 1 for female and 0 for male

Parent report of their day with their child and parent metabolic outcomes

Main effects of parent report of their days with their child

Parent report of their days with their child was not associated with parent metabolic outcomes (all *p*s > 0.10).

Moderation by parent gender

Parent gender moderated the effect of parent report of their days with their child on parent systolic blood pressure (B = 13.861, SE = 6.200, $p = 0.026$; see Table 4). Specifically, as parent reports became less positive, systolic blood pressure increased in fathers but not mothers (see

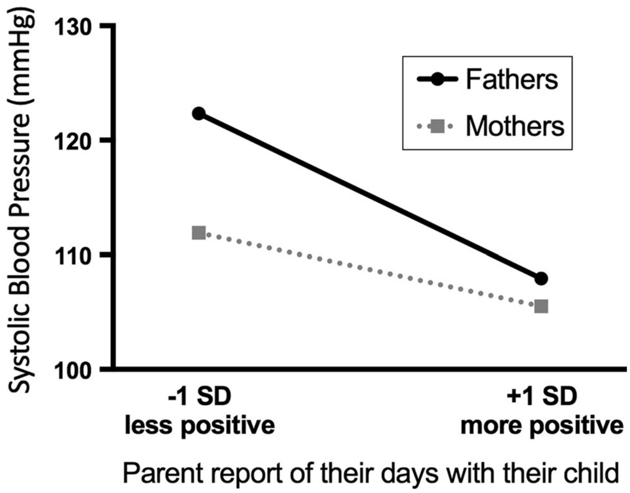

Fig. 1 Average parent reports of their days with their child are graphed at ± 1 standard deviation. Average parent reports were determined by taking the average parent-rating over a 14-day period, with higher numbers indicating more positive days with their child. Parent gender moderated the association between parent report of their days with their child and systolic blood pressure, such that fathers with less positive reports of their day with their child had higher systolic blood pressure, on average. This association was not significant among mothers

Fig. 1). Additionally, the entire model accounted for 26.3% of the variance in systolic blood pressure for parents within the sample. Parent gender did not moderate the association between parent report of their day with their child and other parent metabolic outcomes (all $ps > 0.20$) or the association between perceived child hassles and parent metabolic outcomes (all $ps > 0.20$).

Discussion

In partial support of our first hypothesis, more child daily hassles were associated with greater parent heart rate and total cholesterol levels, on average. These findings complement previous research on the physiological interdependence of people in close relationships (Crowell et al., 2014; Fingerman et al., 2008; Pietromonaco et al., 2013; Slatcher et al., 2010; Slatcher & Selcuk, 2017; Uchino et al., 2014). The association between perceptions of more child daily hassles and greater parent heart rate and total cholesterol levels may in part be due to effects on parent health behaviors although this could not be assessed as part of the present project. For example, parents who perceive their children to experience more hassles may react by eating less healthily. Importantly, we found parents' perceptions of their child's daily hassles to affect parent metabolic health even after controlling for parents' *own* perceived stress over the same two-week period. In addition, we considered parents' perceptions of their child's daily hassles, rather than objective or child self-report measures of child daily hassles. Discrepancies between parent and child reports of relationship measures do exist and increase as children age (Taber, 2010), raising the question of whether our results generalize to child self-report or more objective reports of daily hassles. However, our findings suggest that parents' own perceptions of their children's daily hassles do influence parents' metabolic health.

Child daily hassles did not impact parent metabolic outcomes of systolic blood pressure, diastolic blood pressure, and glycated hemoglobin, suggesting that it may be less influential with respect to certain markers of parent metabolic health. Alternatively, other factors not considered in this study, such as parents' personality characteristics, may serve as moderators of this association. For example, personality traits of hostility, aggression and anger, have been consistently linked to increased cardiovascular risk (Smith, Glazer, Ruiz, & Gallo, 2004) and may affect which parents are physiologically affected by child daily hassles. Other personality characteristics, for example empathy, could also be physiologically influential, as suggested by Manczak et al. (2016). Although metabolic outcomes were not directly addressed, results suggested that adolescent depressive symptoms were associated with greater parent proinflammatory cytokine production, but only if parents were high in empathy (Manczak et al., 2016). Future studies should consider parents' personality characteristics, such as empathy and hostility, to determine whether these traits contribute to the effect of child daily hassles on parent metabolic health. Alternatively, the nature of the hassles experienced by the child could affect the strength of these associations. For example, child daily hassles that have an interpersonal component or that are more closely tied to the parent–child relationship may have more of a physiological effect on parents compared to hassles outside of this relationship. Future studies should consider how this affects parent metabolic functioning.

We did not find support for our second hypothesis of the quality of daily life between parents and their adolescent children affecting parent metabolic health, which may be partly explained by the distribution of parents' reports of their days with their child. Most parents indicated having had primarily positive days with their child, which may explain the absence of main effects considering that negative experiences in particular may trigger adverse physiological sequelae (Taylor, 1991). Similarly, ambivalent parent–child relationships in which parent reports of their days with their child vary from being positive one day to negative the next, were infrequently reported in this sample. Close relationships high in ambivalence have been associated with poorer physiological markers of health (Fingerman et al., 2008; Uchino et al., 2014). Future studies should consider assessments over longer periods of time to increase the capture rate of parent reports of negative and neutral days with their child. Similarly, future studies could focus on more at-risk samples, such as parents from lower socioeconomic groups or with adolescent children who have emotional or behavioral concerns, as these parents may experience more variability in the quality of their days with their child.

Our third hypothesis was largely unsupported in that associations between the parent–child relationship and parent metabolic outcomes for the most part did not vary by parent gender. Effects on systolic blood pressure may represent a possible exception, however, and should be investigated further. As part of the present study we found that reports of less positive days with one's child predicted higher systolic blood pressure among fathers only, and not among mothers. This gender difference is in line with some previous research on interpersonal relationships (Powers et al., 2006; Schreier et al., 2016; Seeman et al., 2002), while contradicting other research that has demonstrated more pronounced physiological effects for women (Appelberg et al., 1996; Levenson et al., 1993; Sneed & Cohen, 2014). In a laboratory experiment involving married couples, Smith et al. (2009) found that both spouses had increased cardiovascular responses to discussions of marital conflict, but that wives showed less cardiovascular reactivity than husbands during both the conflict and during a positive, collaborative task. Conversely, Ewart, Taylor, Kraemer, and Agras (1991) found that wives' systolic blood pressure increased more than husbands' during a laboratory-based problem-solving task, with marital dissatisfaction explaining 50% of the variance. However, to our knowledge, no one has assessed these associations with respect to parent reports of their everyday life with their child. It may be that systolic blood pressure of fathers is more strongly tied to everyday experiences with their child because men may have stronger cardiovascular reactivity to familial conflict, as suggested by Smith et al. (2009). Alternatively, social role theory suggests that traditionally fathers are the primary disciplinarians, more so than mothers (McKinney & Renk, 2008). Therefore, fathers may be more likely to have altercations with their children as a result of disciplinary actions.

The current study has several strengths. First, this is one of the first studies to explore general aspects of the parent–child relationship and metabolic outcomes among parents of adolescent children. Previous studies have focused primarily on the effects of parent–child relationships on the physical health of children (Repetti et al., 2002). Of the few parent–child relationship studies that have included physiological outcomes for parents, most have either assessed parent–child relationships among adult children and their parents (Fingerman et al., 2008) or subsets of parents raising children with particular challenges (Foody et al., 2015; Kuster & Merkle, 2004; Queen et al., 2016). Second, this study assessed five metabolic outcomes, providing a fairly comprehensive assessment of parent metabolic functioning. Third, the inclusion of 62 fathers strengthened the generalizability of the study as previous studies have focused exclusively on characteristics of only the mother–child relationship (Crowell et al., 2014; Hartos & Power, 1997). However, there were relatively few fathers in this sample, which could have limited our ability to detect moderation effects. Fourth, parent ratings of child daily hassles and parent reports of the quality of daily life with their child were determined by taking the average of these ratings over a typical 2-week period, allowing for a higher quality, more in-depth assessment of these aspects of the parent–child relationship, rather than relying on one-time reports assessed as part of a laboratory visit. Although it is possible that this timeframe may not be fully reflective of actual dynamics within the parent–child relationship, it does provide a better assessment than a one-time rating. Lastly, we were able to include parents' own perceived stress as a covariate (Crnic & Greenberg, 1990). Finding main effects of greater child daily hassles on parent heart rate and cholesterol levels over and above parents' own perceived stress levels underscores the influence of the parent–child relationship on parent health.

Despite these strengths, there are several limitations to this study. This study only included one parent for every adolescent child. It is possible that the main effects of child daily hassles on parent metabolic outcomes could be different for the non-participating parent. Future studies would benefit from including both parents from a family to determine whether their relationship with their child affects each parent differently. Similarly, it may be that parents are physiologically affected by aspects of the parent–child relationship, but that personality characteristics (e.g. empathy) and other aspects of the relationship (e.g., emotional expression, satisfaction) are moderating the extent to which this association exists. These differences could make some parents more or less physiologically vulnerable to their child's daily hassles or the quality of day-to-day interactions. For example, it may be beneficial to assess the level of closeness of each parent to the child and consider how this may moderate the extent to which aspects of the parent–child relationship affect parent metabolic outcomes. Similarly, the 3-point scale on which parents reported on the day with their child may have missed more subtle changes in parent–child interactions. Metabolic outcomes were measured prior to the two-week daily dairy, but aspects of the parent–child relationship were averaged over the 2 weeks to reflect typical parent–child transactions that would generalize to the time period leading up to the initial laboratory visit. However, the limited time frame may not reflect typical transactions that a truly longitudinal study design could have captured. Moreover, this was a generally healthy sample of parents and the cross-sectional nature of this study prevents the examination of parents' perception of their child's hassles on daily within-person variation in the physiological outcomes included here. Future research could include parents with more physiological risk factors and examine the effects of day-to-day fluctuations in the parent–child relationship on parents' daily health measures. Numerous analyses and metabolic outcomes were considered, increasing the likelihood of false positive findings. Finally, only total cholesterol was considered, rather than the ratio of high-density lipoprotein to low-density lipoprotein or the ratio for high-density lipoprotein to total cholesterol, which are the preferred measures for cardiovascular risk (Kinosian, Glick, Preiss, & Puder, 1995).

Results of this study suggest that aspects of the parent–child relationship, such as parents' perceptions of their children's daily hassles and parents' reports of their days with their child, may affect certain metabolic markers of parent health. Moreover, aside from less positive parent reports being associated with higher systolic blood pressure in fathers, but not mothers, it appears that parent gender may not substantially affect how parents are physiologically affected by their parenting experiences. Although parents in this study generally presented with levels of metabolic markers within healthy ranges, over time even small increases in biomarkers, e.g., blood pressure or heart rate, may accumulate and contribute to poorer health outcomes in later adulthood. Results of this study suggest the need for further exploration into various aspects of the parent–child relationship and individual differences that may contribute to the physiological health of parents.

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Compliance with ethical standards

Conflict of interest Emily J. Jones, Edith Chen, Cynthia S. Levine, Phoebe H. Lam, Vivian Y. Liu, and Hannah M. C. Schreier declares that they have no conflict of interest.

Human and animal rights and Informed consent All procedures performed in this study involving human participants were in accordance with the ethical standards of the University of British Columbia and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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