Biobehavioral Correlates of Relocation in the Frail Elderly: Salivary Cortisol, Affect, and Cognitive Function

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OBJECTIVES: To examine affect and physiological stress in frail older adults in response to a voluntary nursing home relocation.

DESIGN: Randomized, controlled trial.

SETTING: Long-term care facility located within the greater Philadelphia, Pennsylvania, community.

PARTICIPANTS: Seventy-seven nursing home residents, aged 65 and over.

INTERVENTION: Experimental group residents were relocated to a newly built nursing home facility with a cluster design in the fall of 2001; control group residents were moved after study completion in the spring of 2002.

MEASUREMENTS: Mini-Mental State Examination scores, Observed Affect Rating Scale scores, salivary cortisol, blood pressure, and pulse obtained 1 week before moving and 1 week and 4 weeks after moving.

RESULTS: Relocated nursing home residents demonstrated significant differences in salivary cortisol and mood from a randomly selected group of residents that had not yet moved. Relocation resulted in significantly higher cortisol levels 1 week after the move ($P = .005$), followed by a significant decline in afternoon cortisol at 4 weeks after the move ($P = .03$). Moreover, relocated residents had significantly lower depression and anxiety symptoms and pulse rates than residents who had not yet moved.

CONCLUSION: These findings have important implications for planning medical and social services for relocated elderly. Efforts should be made to prepare individuals for the initial stressors associated with relocation, but it also appears that the stress imposed by relocation is time limited and may begin to ease as early as 4 weeks postmove. **J Am Geriatr Soc 52:1856–1862, 2004.**

Key words: long-term care; relocation; HPA axis; cortisol

Transfer trauma—a term describing a set of negative outcomes that result from involuntarily moving an institutionalized patient from one environment to another—has been the subject of much interest, particularly with respect to the older frail nursing home resident. Early studies suggested that mortality rates posttransfer were higher than expected,[1–3] but poor research design, such as the lack of control group and weak statistical method,[4] coupled with later studies showing no mortality effects[5–7] raised skepticism about early findings. In subsequent decades, researchers have examined a variety of health outcomes in response to institutional relocation, including self-rated health status, cognitive and physical functioning, falls, depression, and anxiety.[8–13] In these studies, residents not exhibiting specific behavioral problems were typically classified as not having stress, irrespective of what their internal physiological responses might have been.

Disparities in findings also raise the question of whether adverse relocation effects may be offset if the residents are moved to better living conditions. Some vehemently argue that there are no ill effects of relocation;[6,14] others add that a move to a new and improved physical environment may ultimately have positive effects on residents well-being.[15,16] Nonetheless, disagreement as to the direction, extent, and nature of postrelocation health effects persists. Despite the controversy, most agree that institutional relocation is a major life change and consequently a stressful event.

Much of the existing literature relies on self-ratings of stress from nursing home residents or global perceptions of stress reported by care providers, but in recent decades advancements in the noninvasive measurement of biological processes have made it possible to expand exploration of this topic into the biosocial realm. Two studies have examined physiological reactions to the stress of nursing home relocation.

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The first study[17] examined 54 nursing home residents' single morning serum cortisol level before and after an involuntary transfer. Postrelocation plasma cortisol levels were significantly higher than baseline for men but not for women and significantly higher for demented than nondemented residents.

The second study provided descriptive information on 50 male residents relocated within a 900-bed medical center.[18] Measures of blood pressure, pulse, respiration, anxiety (State Train Anxiety Inventory), and cognitive performance (Mini-Mental State Examination (MMSE)) were obtained 2 months before and 2 weeks and 6 weeks after relocation. The authors found changes in diastolic BP from before to after the relocation but no changes in the residents' reports of anxiety. Although provocative, as with much of this literature, the lack of randomized control groups in these studies limits the interpretation of the findings.

Over the last decade, cortisol has become one of most commonly employed physiological markers of individual differences in the stress response. Cortisol is a glucocorticoid hormone produced by the adrenal cortex in response to activation of the hypothalamic-pituitary-adrenal (HPA) axis. Under normal conditions, when a challenge or perceived threat is present, the HPA axis is activated, resulting in an increase in cortisol. After the challenge has been resolved, cortisol levels return to baseline.[19,20] The HPA axis is thought to be especially active when a threat is perceived to overwhelm perceived coping resources.[21,22]

Traditionally, cortisol levels are measured in serum or plasma, but technical advances have made the noninvasive assessment of cortisol in saliva possible.[21] Measurement of cortisol via saliva has been used in numerous studies in various special populations[23–28] and when repeated sampling of blood or urine would be traumatizing.

Surprisingly, only two studies of the frail institutionalized elderly have employed this innovative approach. One study[29] collected six salivary samples from 10 medically stable male residents during a commonly perceived stressful event (assisted bathing). Another researcher[30] collected early morning saliva samples from 10 residents with Alzheimer's disease in response to a therapeutic touch intervention.

Several authors[14,31,32] posit that relocation is a process consisting of three distinct stages, each with its own dynamics and potential for stress: (1) a preparation stage, before relocation, otherwise known as the anticipatory stage; (2) an effect stage, within which the actual relocation and adjustment occurs; and (3) a settling-in stage. In the cognitively frail population, the anxiety from the lack of familiar environment coupled with the lack of coping resources results in an increased vulnerability to stress from relocation.[3,32] Accordingly, it is possible to draw upon these theoretical models and estimate the pattern of stress response during relocation. It is hypothesized that, stress levels in the transfer group during the effect stage or early phase of relocation will be higher than those of the control group. In addition, it is hypothesized that the settling-in stage will be characterized as a period of adjustment demonstrated by a decline in emotional and physiological stress. For the purpose of this study, apparent affect scores as measured using the Apparent Affect Rating Scale (AARS) served as a measure of emotional stress. Heart rate, blood pressure, and cortisol levels served as measures of physiological stress. Morning and afternoon values of cortisol were examined because cortisol levels demonstrate slower returns to baseline in chronically stressed[33] and older subjects,[34] and early evidence shows that afternoon cortisol is more reactive to relief in stress than morning values.[35]

METHODS

This study involved a naturally occurring experiment in which residents of the Philadelphia Geriatric Center were relocated from the center's campus in Philadelphia to a new nursing home facility in Horsham, Pennsylvania, the Madlyn and Leonard Abramson Center for Jewish Life, approximately 15 miles away. The new facility opened in two phases, and residents' moves were randomly ordered, effectively creating two groups of movers: a fall group and spring group. The first group of residents, which served as the experimental group (movers), moved in the fall of 2001. The second group, which served as the control group (nonmovers), was relocated after the study concluded in the spring of 2002. Approximately four residents were moved to the new facility per day over the 7-month observation period.

Sample

One hundred sixteen residents were recruited into the study during June 2001 according to procedures approved by the Center's institutional review board. Of the 72 residents able to provide informed consent, 53 provided written self-consent (response rate 74%). Information packets describing the study were also mailed to family members of self-consenting residents. Of the 181 residents that were too impaired to comprehend informed consent, 79 family members signed and returned written consent forms (response rate 44%). All residents were approached for verbal assent at the beginning of the study and at each data collection point. The signed consent rate for the two groups combined was 53%. Of the 132 residents for whom consent was obtained, 116 assented to provide data at baseline.

Because of the agency's mission to serve the poor, Jewish elderly, a majority of the sample received Medicaid benefits (84%) and was white (100%), both much higher than national averages. The sample was also strikingly old; 73% of residents were aged 85 and older, compared with only 40% of nursing home residents nationally. The residents' average Medicaid case mix score (reflecting clinical complexity and cognitive, psychological, and physical functioning) was 1.03, indicating that residents were only slightly frailer than those found nationally in similarly sized facilities in metropolitan areas. In addition, most residents in the study had unusually long lengths of stay: 87% of subjects had been residents for 2 or more years.

Many facets of the treatment of institutionalized elders, such as disease states, cognitive status, immobility, fatigue, medications, and hydration practices, may affect the ability to adequately assess salivary biomarkers. Xerostomia (dry mouth) is a particular challenge affecting up to half of nursing home residents.[36–38] In the current study, one-third of all attempts to collect saliva failed to provide a valid saliva sample. Thus, of the 116 residents recruited at

baseline, 77 were able to provide valid saliva samples and were included in follow-up. Missing rates were not statistically different between the experimental and control groups ($T = 1.6$; $P = .11$). Baseline clinical characteristics (age, sex, cognitive status, functional status, medications) did not differ significantly between those providing at least one and those providing no saliva samples.

Relocation Process and Environmental Change

Approximately 2 weeks before the scheduled move date, family members were notified that their relative had the option of moving. Ninety-five percent of the families agreed to the relocation. Several days before the scheduled move date, a social worker and a chaplain prepared individual residents for relocation. During formal preparation procedures, residents were shown photographs of the new facility, allowed to move a few personal items, and encouraged to talk about their feelings about the move. In addition, all residents and family members were encouraged to attend meetings about the relocation. During the postmove period, staff continued to provide information and support as needed.

The Philadelphia facility and the new Horsham facility provided fundamentally different physical environments; the Philadelphia facility provided double-occupancy rooms on double-loaded hospital-like corridors and, for those in advanced stages of dementia, a special care unit built in a large, rectangular, open space with rooms around the perimeter. In contrast, the Horsham facility, known as the Abramson Residence, was built using a cluster design, providing private rooms and maximal natural lighting, in a homelike setting with small, medium, and large social spaces.

Data Collection

For each resident, baseline data were collected over the course of 1 day between mid-July 2001 and mid-August 2001. During this time, residents had knowledge that a new facility was being built but had no specific knowledge about when the building would be completed or when they would be moving.

Data were also collected over the course of 1 day at three additional intervals: 1 week (2–5 days) before, 1 week (7–9 days) after, and 4 weeks (26–32 days) after the move. Members of the control group were randomly assigned a "move" date to serve as a reference point for additional data collection so that the experimental and control groups had measures taken over comparable periods.

Over the course of each day, a registered nurse, specifically trained in observational and physiological data collection techniques, collected four distinct types of data: (1) saliva samples from which cortisol was measured, (2) 5-minute observations of affect (e.g., anger, depression, anxiety) scored using the AARS, (3) cognitive function using the Folstein MMSE, and (4) other physiological measures (e.g., blood pressure, pulse). Each encounter with a resident was designed to take approximately 30 minutes.

Measures of Stress, Affect, and Cognition

Salivary cortisol possesses diurnal qualities, that is, levels shift through the course of the day. For the typical person, the highest levels occur approximately 30 minutes after waking; levels then decline through the day and evening. Saliva was collected from subjects four times a day across each of the 4 days: within 30 minutes of awakening and every 3 hours thereafter (mid-morning, early afternoon, and late afternoon). Care was taken when collecting saliva to avoid collection immediately after mouth cleaning, meals, snacks, or medications.[23,39,40] In addition, meal times and snack patterns remained the same at the new facility. For participants unable to drool into a specimen container, the tip of a cotton-braided rope was placed in the mouth and held in place until saturated with saliva. The saliva samples were then transferred into 2 mL cryovials and stored frozen ($\leq -20^{\circ}C$) until assayed.

All samples were assayed for salivary cortisol using a highly sensitive enzyme immunoassay (Salimetrics, State College, PA) 510 k approved for use by the Food and Drug Administration as a diagnostic measure of adrenal function. The test uses only 25 μL of saliva (for singlet determinations), has a lower limit of sensitivity of 0.007 μg/dL, a range of sensitivity from 0.007 to 1.8 μg/dL, and average intra- and interassay coefficients of variation of 4.13% and 8.89%, respectively. Method accuracy, determined using spike recovery, and linearity, determined using serial dilution, are 105% and 95%, respectively. Values from matched serum and saliva samples show the expected strong linear relationship (r (17 subjects) = 0.94, $P < .001$).

Observation of affect was observed and scored using the AARS[41] four times over the course of the day (early morning, mid-morning, early afternoon, and late afternoon), before the collection of each saliva sample. The scale consists of five items; requires 5 minutes of observation; and provides reliable and valid readings of depression, anxiety, anger, pleasure, and interest for the cognitively intact and impaired. Psychometric properties have been well demonstrated, including interobserver reliability (interobserver correlation coefficient = 0.92 for the current study), convergent and discriminant validity, and support for its two-factor structure.[42]

Cognitive assessment was conducted using the MMSE[43] after the mid-morning saliva collection. The MMSE has demonstrated good test-retest reliability ($r = 0.80$–0.95). It is traditionally used in tracking progressive declines in cognitive functioning.

Trained nurse researchers collected physiological measures at each interval. These measures included diastolic and systolic blood pressure and pulse intensity and were collected after early-afternoon saliva collection.

Data Analysis

Hypothesis testing used repeat-measures analysis of variance (ANOVA)[44] with treatment (the relocation) nested within subjects. An advantage of this approach is that missing data and unbalanced designs can be accommodated.[45] Using the method proposed by previous authors,[45] correlation between observations were accounted for. Two-way repeat-measures ANOVAs were conducted, with experimental/control (e.g., moved or not moved) a between-subject factor and each wave a within-subject factor for morning and afternoon levels, respectively. The effect of select covariates (cognitive status, sex) was tested using a three-way repeat measures ANOVA, with group (e.g., cognitively impaired/intact; male/female) and experimental/control group between-subject factors and time a within-subject factor. Because of skewed

cortisol distributions, cortisol values were transformed logarithmically (natural log = ln).

RESULTS

For the vast majority of sample characteristics, no significant differences were found at baseline between movers and nonmovers (Table 1), but at baseline, nonmovers had significantly higher morning cortisol levels than movers.

Table 2 compares mean levels of cortisol, pulse and blood pressure, and cognition and affect of movers and nonmovers at three subsequent waves. There were no significant differences between movers and nonmovers 1 week before the move. One week after the move, there were no differences in average cortisol levels between movers and nonmovers, but movers had lower pulse rates than nonmovers ($P = .001$) and significantly lower scores of anger ($P = .05$), anxiety ($P = .01$), and sadness ($P < .001$) and higher scores of mild pleasure ($P = .04$). At 4 weeks after the move, movers had higher midmorning cortisol levels ($P = .03$) than nonmovers. In addition, movers had significantly lower scores on pulse rate ($P < .001$) anxiety ($P < .001$) and sadness ($P < .001$) than nonmovers.

Although statistically significant differences between movers and nonmovers in cortisol are not apparent, different patterns are suggested when the data are displayed graphically. As shown in Figure 1, morning cortisol peaked for the movers at 1 week after the move. Baseline morning cortisol levels averaged 0.27 μg/dL in the movers but increased to about 0.53 μg/dL 1 week after the move. Morning values declined to 0.43 μg/dL 4 weeks after the move, although not to premove levels. For nonmovers, the early-morning cortisol values remained relatively stable. In the ensuing 3 weeks, average cortisol over the rest of the day (average over all but early-morning values) declined sharply for the movers but remained relatively constant for the nonmovers (Figure 2).

Turning to the multivariate results (Table 3), residents who were moved demonstrated a significantly greater

Table 1. Comparison at Baseline of Movers and Nonmovers

Characteristic	Movers n = 34	Nonmovers n = 43
Age, mean ± SD	87.2 ± 7.8	88.6 ± 8.6
Length of stay in years, mean ± SD	5.0 ± 2.2	4.7 ± 2.1
Sex, n (%)		
Male	8 (23.5)	9 (20.9)
Female	26 (76.5)	34 (79.1)
Case mix score, mean ± SD	1.10 ± 0.44	1.23 ± 0.59
Insurance type, n (%)		
Medicaid	24 (70)	32 (79)
Medicare	1(2.3)	1 (2.3)
Private pay	2 (5.7)	6 (13.9)
Medicaid hospital	7 (20)	4 (9.3)
Number of saliva samples obtained, mean ± SD	3.0 ± 1.0	3.3 ± 0.9
Saliva collection times, mean ± SD		
Early morning	7:51 ± 0:25	7:50 ± 0:29
Mid-morning	10:02 ± 0:29	9:58 ± 0:36
Mid-afternoon	14:23 ± 0:35	14:25 ± 0.27
Late afternoon	16:44 ± 0:32	16:51 ± 0:29
Time of cardiovascular assessment, mean ± SD	10:37 ± 1:26	10:32 ± 1:16
Cortisol levels in μg/dL, mean ± SD		
Early morning	0.27 ± 0.11	0.44 ± 0.27*
Mid-morning	0.36 ± 0.23	0.28 ± 0.18
Mid-afternoon	0.26 ± 0.15	0.28 ± 0.23
Late afternoon	0.23 ± 0.08	0.30 ± 0.23
Diastolic blood pressure, mmHg, mean ± SD	72.6 ± 6.5	73.0 ± 7.0
Systolic blood pressure, mmHg, mean ± SD	121 ± 9.9	121 ± 10.3
Pulse, beats per minute, mean ± SD	77.9 ± 5.5	78.7 ± 6.0
Mini-Mental State Examination score (range 0–30), mean ± SD	12.9 ± 9.5	13.7 ± 8.9
Observed emotion ratings, mean ± SD		
Anger (range 1–15)	4.7 ± 1.8	5.0 ± 2.7
Anxiety (range 1–15)	6.5 ± 3.7	6.1 ± 2.7
Alertness (range 1–15)	15.9 ± 4.0	14.8 ± 4.1
High pleasure (range 1–15)	4.7 ± 1.9	4.6 ± 1.5
Mild pleasure (range 1–15)	7.5 ± 3.2	7.4 ± 3.6
Sadness (range 1–15)	5.9 ± 2.0	6.5 ± 2.3

* Significant ($P = .03$) difference in means between movers and nonmovers at baseline.
SD = standard deviation.

Table 2. Physiological Stress, Cognition, and Observed Emotion: Movers and Nonmovers at −1,+1, and+4 Weeks

	−1 Week		+1 Week		+4 Weeks	
	Movers n = 28	Nonmovers n = 41	Movers n = 33	Nonmovers n = 34	Movers n = 32	Nonmovers n = 39
Parameter	Mean ± Standard Deviation					
Cortisol levels, μg/dL						
Early morning	0.32 ± 0.16	0.38 ± 0.22	0.53 ± 0.29	0.39 ± 0.20	0.43 ± 0.31	0.38 ± 0.20
Mid-morning	0.30 ± 0.14	0.34 ± 0.18	0.34 ± 0.14	0.31 ± 0.22	0.45 ± 0.27	0.29* ± 0.20
Mid-afternoon	0.25 ± 0.14	0.24 ± 0.14	0.27 ± 0.18	0.25 ± 0.17	0.23 ± 0.18	0.20 ± 0.12
Late afternoon	0.32 ± 0.14	0.25 ± 0.17	0.28 ± 0.25	0.20 ± 0.11	0.16 ± 0.09	0.16 ± 0.10
Diastolic BP, mmHg	72.6 ± 14.4	68.9 ± 9.8	69.9 ± 8.8	68.8 ± 10.0	68.2 ± 8.0	70.7 ± 13.3
Systolic BP, mmHg	125.2 ± 19.8	123.3 ± 19.7	128.1 ± 15.5	124.9 ± 22.0	123.4 ± 16.3	124.5 ± 24.7
Pulse	78.6 ± 5.9	79.7 ± 7.8	70.6 ± 8.3	79.0* ± 10.8	72.2 ± 7.9	80.8† ± 7.4
Mini-Mental State Examination score	15.7 ± 10.3	13.2 ± 10.2	11.6 ± 10.4	15.8 ± 9.8	14.5 ± 10.3	12.6 ± 9.7
Observed emotion ratings						
Anger	5.8 ± 3.2	5.0 ± 2.1	4.3 ± 1.1	5.2* ± 2.0	4.7 ± 1.5	4.9 ± 1.5
Anxiety	7.2 ± 3.4	7.4 ± 3.6	5.2 ± 3.1	7.3† ± 2.8	4.8 ± 1.4	7.4 † ± 3.0
Alertness	17.7 ± 2.2	17.4 ± 3.3	18.7 ± 2.1	17.7 ± 3.1	18.5 ± 1.8	18.0 ± 2.6
High pleasure	4.6 ± 1.2	4.5 ± 1.2	4.4 ± 1.1	4.4 ± 0.9	4.2 ± 0.6	4.4 ± 1.5
Mild pleasure	9.4 ± 4.2	8.8 ± 4.6	10.6 ± 4.6	8.1* ± 3.9	9.2 ± 3.2	8.8 ± 3.6
Sadness	6.2 ± 2.9	6.6 ± 2.4	5.0 ± 2.5	7.7† ± 2.4	4.4 ± 1.1	6.7† ± 2.2

* $P < .05$; † $P < .01$.
BP = blood pressure.

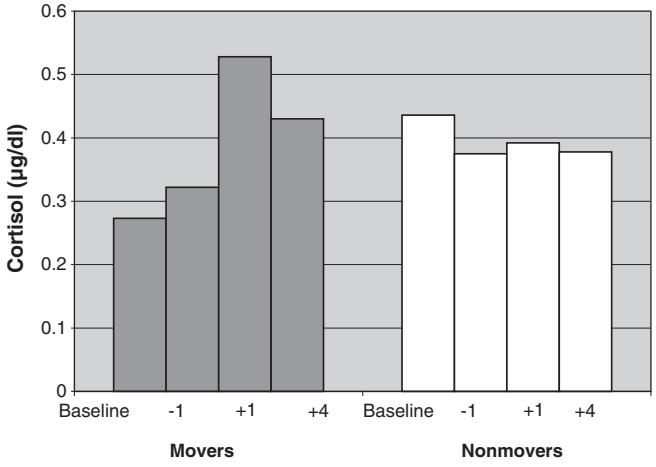

Figure 1. Movers versus nonmovers: morning cortisol by wave.

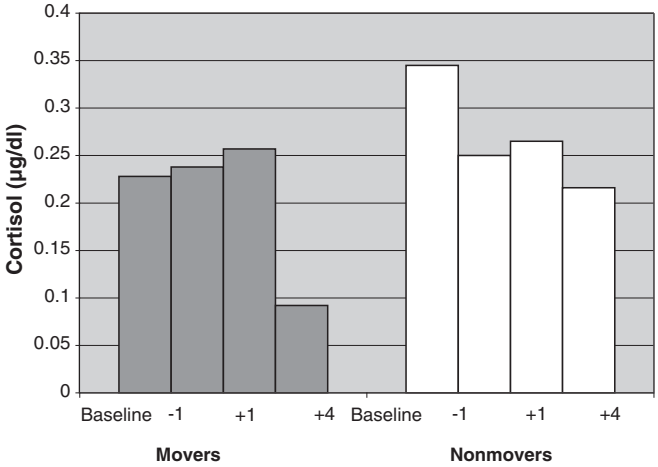

Figure 2. Movers versus nonmovers: afternoon cortisol by wave.

increase from baseline in their early morning cortisols 1 week after the move than those who had not yet moved ($F = 8.61$, $P = .005$). In addition, movers demonstrated a significant decline from baseline in their afternoon cortisol at 4 weeks after the move ($F = 4.92$, $P = .03$). Moreover, movers demonstrated a significantly greater decline in pulse ($F = 10.71$, $P = .002$), anxiety ($F = 10.22$, $P = .002$), and sadness ($F = 8.3$, $P = .005$) 4 weeks after the move than the nonmovers. Tests of select covariates (cognitive status, sex) using three-way repeat measures ANOVA were not significant (not shown).

DISCUSSION

This study is the first of its kind to explore biobehavioral response by older frail persons to a nursing home relocation using an experimental design. Residents relocated from a nursing home facility with traditional double-occupancy rooms on double-loaded hospital-like corridors to a newly built facility with private rooms in a cluster design demonstrated significantly greater changes in cortisol and affect than did their counterparts who did not move. In this study, the stress response was time limited and on balance was evidenced by a decline in cortisol and an improved affect. Two noteworthy patterns emerged in the analyses. First, morning cortisol levels were higher 1 week after relocation, although adjustment to the new environment appears to begin as early as 4 weeks postmove, as evidenced by the slight decline in morning cortisol levels and sharp decline in afternoon cortisol levels within the group. Preliminary

Table 3. Repeat Measures Analysis of Variance Model Results: Difference Between Movers and Nonmovers in the Change from Baseline

	−1 Week		+1 Week		+4 Weeks	
Outcome	F	*P*-value	F	*P*-value	F	*P*-value
Cortisol levels						
Early morning (n = 173)	0.65	.424	8.61	.005	1.37	.251
Mid-morning (n = 169)	1.41	.239	0.01	.926	0.75	.392
Mid-afternoon (n = 156)	0.06	.806	0.02	.879	0.03	.872
Late afternoon (n = 128)	6.22	.015	1.49	.226	4.92	.030
Diastolic BP (n = 263)	1.83	.181	0.44	.509	0.45	.505
Systolic BP (n = 263)	0.22	.639	1.02	.316	0.0	.954
Pulse (n = 267)	0.02	.893	10.46	.002	10.71	.002
Observed emotion rating						
Anger (n = 248)	1.50	.167	0.40	.531	0.40	.531
Anxiety (n = 232)	0.01	.915	5.11	.027	10.22	.002
Alertness (n = 235)	0.62	.434	0.43	.977	0.26	.614
High pleasure (n = 232)	0.00	.983	0.07	.798	0.10	.749
Mild pleasure (n = 233)	0.31	.582	4.29	.042	0.02	.702
Sadness (n = 232)	0.22	.644	9.68	.003	8.30	.005

BP = blood pressure.

evidence suggests that afternoon cortisol levels may be more reactive to relief in stress than morning levels.[35] These findings support this hypothesis and are consistent with the literature demonstrating that the initial period after relocation is the most stressful.[4,6,9,13,15] Second, there was a striking improvement in affect in the movers. Observations of anxiety and sadness significantly declined in the movers when compared with nonmovers.

Movers' pulse rates decreased after the move, and their average pulse rate postmove was lower than that of the nonmovers, a finding that has been previously demonstrated in postrelocation samples,[15] although the mechanism underlying this finding remains unclear. Moreover, physiological measures such as blood pressure and pulse may not be the most relevant indexes in determining stress in response to relocation in the frail elderly. There are multiple influences on these measures that are difficult to control in this type of population.

The lack of cognitive responses to relocation suggests that relocation has little effect on cognitive abilities, a finding supported in the literature,[32] but the MMSE may not have captured subtle changes in cognition, especially in those with very low or very high ability.

This study did not allow for testing of whether the type of move-preparation activities undertaken with the residents had an effect on the size or duration of the stress response, but it is interesting to note that the inclusion of a move-preparation program based on the elements recommended in the current literature[46] did not alleviate the residents' initial stress response altogether. Designing a program to minimize physiological stress reactivity and improve affect would be an important contribution to this literature. The study suggests that such a program should extend beyond the relocation itself into the first weeks in the new environment.

The generalizability of the study is limited in several important respects. The sample was homogenous with respect to race and culture. It is unclear whether the physiological responses observed here are generalizable to other groups. Equally important, only persons able to provide adequate saliva samples were included in the analysis, although they did not differ in a clinically meaningful way from those providing samples. Finally, the relocation involved moving to a fundamentally different environment purposefully designed to support residents' quality of life. Whether improvements in affect and physiological indicators of stress would occur after location to a less-supportive environment is unclear.

Although much larger than most laboratory-based experiments of physiological stress, analysis was hampered by sample size. Potentially important factors, such as cognitive status, sex, and HPA dysregulation that might mediate the relationship between an external challenge (in this case a relocation) and the stress response could not be tested. In addition, sample size did not permit exploration of the joint distributions of affect and cortisol in this sample. Nevertheless, although favorable changes in affect have been demonstrated in relocated geriatric patients,[47] these are the first results demonstrating improvements in cortisol and affect in response to relocation. These findings are consistent with recent evidence suggesting that salivary cortisol represents an objective neuroendocrine measure for changes in affect.[48]

Technological advances of the past 2 decades have created new opportunities for developmental scientists to integrate biological measures into their research programs. This new biosocial perspective speculates that biological functions set the stage for behavioral adaptation to environmental challenges. Recent reviews[49,50] indicate that, although many investigators indicate the importance of specifying biosocial relationships in theoretical models, few studies actually test them.

Salivary cortisol measures can serve as useful endpoints in further research on interventions designed to attenuate

the stress response in frail older adults. Further analysis is needed to establish whether diurnal cortisol rhythms predict a nursing home resident's clinical course, including survival, and is the next step of analysis.

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