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ARTICLE

Heart Disease, Physical Activity Trajectories, and Gender.

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Abstract

Objectives: The first purpose was to identify distinct physical activity growth trajectories for light and moderate to vigorous physical activity (PA) after hospitalization for heart disease (i.e., to identify sub-groups of patients whose PA trajectories are similar to each other, but different from patients in other PA trajectory groups). The second purpose was to determine if gender predicted sub-group membership for each PA intensity. *Design and Setting:* Participants (N=554) completed a questionnaire in hospital and at 2, 6, 12, and 24 months after hospitalization. *Results:* Latent class growth curve analyses showed two classes of patients emerged for light intensity PA that were labeled *Inactive Maintainers-Light* (72.2% of the sample) and *Low Active Maintainers-Light* (27.8%). For moderate to vigorous PA, 87.8% of the sample was labeled *Inactive Maintainers* (i.e., remained inactive for the entire 2-year period), whereas 12.2% were labeled *Active Maintainers* (i.e., remained active for the 2-year period). Gender did not predict light intensity PA group membership, however, females were significantly more likely to be in the *Inactive Maintainer* for moderate to vigorous PA compared to males (odds ratio = 3.47). *Conclusion:* The association between gender and PA trajectories after hospitalization for heart disease may be intensity dependent. **Health & Fitness Journal of Canada 2015;8(1):3-13.**

Keywords: Heart Disease, Gender, Physical Activity, Intensity

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Introduction

Recent statistics show that since 1984, the number of cardiovascular disease deaths for females has exceeded those for males. Further, women are more likely to die within a year of a myocardial infarction compared to men (Roger et al., 2012). One potential explanation to explain this gender disparity is that females engage in less physical activity (PA). Indeed, research has shown that males and females living with heart disease who engage in ≥ 30 minutes of moderate to vigorous PA four or more times per week can reduce their cardiovascular-related mortality by up to 40% compared to patients who engage in no PA (Moholdt et al., 2008). Further, Moholdt et al. (2008) found that the same frequency (i.e., ≥ 4) and duration (i.e., ≥ 30 minutes) cut-points at a light intensity also reduced patients' cardiovascular-related mortality by up to 30% compared to patients who engaged in no PA. Therefore, it is clear that PA has a beneficial effect; however, the next step is to discern whether a gender difference exits from a PA perspective.

To date, the vast majority of gender-based PA research in heart disease has focused on patients who attend cardiac rehabilitation, which has consistently shown that women have significantly lower adherence rates and are more likely to drop-out of cardiac rehabilitation compared to males (Blanchard et al., 2002a; Blanchard et al., 2002b; Halm et al., 1999; Marzolini et al., 2008). Although informative, this research provides little information regarding the PA trajectories of patients who do not attend cardiac rehabilitation (i.e., 78% to 85% of the patient population: Suaya et al., 2007; Suskin et al., 2003). Unfortunately, very little is known about these patients' PA trajectories. In one study, results showed that female patients engaged in significantly less moderate to vigorous PA at two months after hospitalization (mean $kcal \cdot wk^{-1}$ = 1354.35) compared to males (mean $kcal \cdot wk^{-1}$ = 2069) and female patients showed a significantly larger decline in PA by 12 months (female $kcal \cdot wk^{-1}$ = 979.36; male $kcal \cdot wk^{-1}$ = 1743.21)(Blanchard et al., 2007). In another study, Jenkins et al. (1998) showed that men engaged in significantly more light intensity PA (i.e., walking) than women at one, two, six and 12 months after hospitalization for coronary artery bypass graft (CABG) surgery, although PA increased for both groups during this time period. Therefore, coupling these findings would suggest that female patients engage in significantly less light and moderate to vigorous PA compared to men after hospitalization, which may partially explain the gender disparity in mortality.

Although the above preliminary PA trajectory studies are promising, they have limitations that need to be considered. First, neither study included light and moderate to vigorous PA in the same sample. Second, different PA measures were used (i.e., the Jenkins Activity Checklist to measure light PA and the 7-day PAR to measure moderate to vigorous PA) between studies. Third, the samples between studies were very different (e.g., elderly CABG patients: Jenkins et al., 1998) versus a heterogeneous sample in terms of age and diagnoses (Blanchard et al., 2007). As the PA trajectories appeared to vary by intensity (i.e., light PA increased, whereas moderate to vigorous PA decreased) and gender (i.e., male patients did more PA), including both PA intensities within the same heterogeneous sample using the same PA measure will help paint a clearer picture of any potential gender difference by intensity. Finally, both studies only tracked patients' PA levels for one year and longer-term follow-up (e.g., up to two years after hospitalization) will more accurately reflect the sustainability (or lack thereof) of PA from an intensity and gender perspective.

The first purpose of the current study was to examine the light and moderate to vigorous PA growth trajectories of heart disease patients from baseline to six, 12, and 24 months after hospitalization using latent class growth analysis (LCGA). This person-centered approach is particularly useful with longitudinal data as it allows for heterogeneity in the growth trajectories (i.e., it identifies distinct PA trajectories or sub-groups of patients who are similar to each other, but different from patients in other PA trajectory groups) (Muthen et al., 2000) It was hypothesized that more than one distinct PA trajectory would emerge for each intensity (hypothesis #1)(Sweet et al., 2011). The second purpose was to determine if gender predicted group membership for a given intensity. It was hypothesized that gender would be an important group membership predictor (hypothesis #2)(Blanchard et al., 2007; Jenkins et al., 1998).

Methods

Participants

The participants were enrolled in the *Tracking Exercise After Cardiac Hospitalization* trial (Reid et al., 2006), which is a prospective study designed to examine the pattern and predictors of PA in 801 participants living with heart disease. For the current study, the 554 (410 men / 145 women) participants who did not attend any form of cardiac rehabilitation were included in the analysis. Demographics for these patients are presented in Table 1.

Table 1: Demographic and clinical characteristics for the male and female patients.

Patient Characteristics		Men (n = 406)	Women (n = 144)
Demographics			
Age	< 65 yr	62.8	56.9
	≥ 65 yr	37.2	43.1
Education	< Grade 12	69.0	75.0
	≥ Grade 12	31.0	25.0
Marital Status	Other	21.7	42.4
	Married / Common-law	78.3	57.6
Employed	Not Employed	55.9	66.0
	Employed	44.14	34.0
Clinical			
Diagnosis–AMI	No	64.5	60.4
	Yes	35.5	39.6
Obese	No	67.5	60.4
	Yes	32.0	38.2
Comorbidities	0	26.8	18.8
	≥ 1	73.2	81.3

Note. * $p < 0.05$; ** $p < 0.01$; OR = odds ratio

Procedure

Approval of the study procedures was obtained from the Research Ethics Committee at each of the three tertiary care cardiac centers in Ottawa and Kingston, Canada. Participants eligible for enrolment were between the ages of 20 and 85 years, and were hospitalized for AMI, PCI, or CABG. Those with contraindications to PA (e.g. unresolved unstable angina; uncontrolled cardiac arrhythmias causing symptoms or haemodynamic compromise; neuromuscular, musculoskeletal, or rheumatoid disorders exacerbated by PA; uncontrolled diabetes; or chronic infectious diseases such as mononucleosis, hepatitis, AIDS) were excluded. Potential study participants were recruited in-hospital by a study coordinator at each site and all participants provided written informed consent. Participants completed a baseline questionnaire that included the demographic and PA scales needed for the current study. Participants were then contacted at two, six, 12, and 24 months after hospital discharge. At each time point, a questionnaire, a stamped envelope, and instructions to return the questionnaire within 1 week of receiving it was mailed to the participant. For the current paper, the PA measure (i.e., Godin Leisure-Time Exercise Questionnaire) was not obtained at two months, therefore, this time point was not included in the current analysis.

Measures

Demographic and clinical characteristics included age, gender, education, employment, marital status, height and weight (i.e., to calculate body mass index), and the presence or absence of comorbidities (i.e., lung disease, arthritis, diabetes, stroke, and poor circulation) that were transformed into comorbidity score (0 = no comorbidities; 1 = ≥ 1 comorbidity). Diagnosis was obtained via chart review at the time of hospitalization(Reid et al., 2006).

Physical activity was assessed by the leisure score index (LSI) of the Godin Shephard Leisure-Time Exercise Questionnaire (Godin et al., 1985). The LSI measures the frequency of mild, moderate, and strenuous PA performed for at least 15 minutes in duration during free time in a typical week. The frequency of PA at each intensity level is then multiplied by its metabolic equivalent (MET: 1 MET is the energy expended by the body at rest). Specifically, for light PA, the outcome variable was created via the following formula: 3 METS x frequency of mild PA. For moderate to vigorous PA, the outcome variable was obtained via the formula: (5 METS x frequency of moderate PA) + (9 METS x frequency of strenuous PA). An independent evaluation of this measure found its reliability and validity to compare favourably to nine other self-report measures of PA(Jacobs et al., 1993).

Analyses

It has been previously reported that complete data for the TEACH trial was available for 100%, 78%, 72%, and 72% of the 801 participants at baseline, two, six and 12 months respectively and the expectation maximization algorithm was used to impute the follow-up data(Reid et al., 2006). With the availability of the two-year data, we found that 623 patients (i.e., 77.8%) completed the PA measure. Therefore, these data were imputed using the same procedure expectation maximization algorithm prior to conducting the main data analyses.

To address purpose #1 (i.e., to determine if distinct sub groups of patients exist with their own PA trajectories), a series of latent class growth analyses (Jones et al., 2001) were conducted in MPLUS 6.1. Specifically, a model was specified for each intensity wherein a latent intercept growth factor (i.e., baseline PA) and a latent slope growth factor (i.e., change in PA over time coded 0 = baseline, 6 = 6 months, 12 = 12 months, 24 = 24 months) was created. Quadratic terms were also tested for their necessity in the models. To identify the number of classes within a given intensity, the Bayesian Information Criterion (BIC) was used. Smaller BIC's indicate a better model and differences of 10 or more are considered as evidence favoring one model over another (Raftery, 1995). Once the final number of groups was identified for each intensity, another series of latent class growth analyses were conducted such that each demographic and clinical variable predicted group membership for a given intensity. The coefficient can then be interpreted as an odds ratio predicting group membership (Muthen et al., 2000). All significant predictors for a given intensity were then entered into a final model with gender to delineate whether gender predicted group membership (hypothesis #2).

Results

(Hypothesis #1): With respect to light intensity, results showed that two main classes emerged (i.e., Model 2 in Table 2). Although the 3-class model significantly reduced the BIC, the 2nd class had only 11 participants, making it difficult for subsequent analytical comparisons. Therefore, Figure 1 represents the final LCGA, which showed that class 1 (i.e., *Inactive Maintainers – Light Intensity*) comprised 77.2% of the sample and demonstrated a significant quadratic trend that showed modest increases from baseline to 12 months and a steady decline up to two years. The second class (i.e., *Low Active Non-Maintainers – Light Intensity*) comprised 27.8% of the sample and averaged 15.09 METS per week of

Table 2: Latent class growth curve analyses by physical activity intensity.

	Class 1	Class 2	Class 3	Class 4	BIC	Δ BIC
Light Intensity						
Model 1	*n = 546*					
Intercept	8.89					
Linear Trend	0.64*					
Quadratic Trend	-0.02*				15150.35	
Model 2	*n = 409*	*n = 137*				
Intercept	6.51	15.09***				
Linear Trend	0.62*	0.68***				Model 1 vs 2
Quadratic Trend	-0.02*	-0.03***			14951.24	Δ = 199.12
Model 3	*n = 351*	*n = 11*	*n = 184*			
Intercept	5.42	10.52	15.02			
Linear Trend	0.72*	1.59*	0.42*			Model 2 vs 3
Quadratic Trend	-0.03*	-0.002	-0.02*		14811.19	Δ = 140.05
Model 4	*n = 12*	*n =279*	*n = 249*	*n = 6*		
Intercept	16.19	5.26	12.55	11.36		
Linear Trend	3.29*	0.55*	0.61*	-0.02		Model 3 vs 4
Quadratic Trend	-0.13*	-0.02*	-0.03*	0.08*	14747.19	Δ = 64
MVPA						
Model 1	*n = 546*					
Intercept	11.01					
Linear Trend	1.97*					
Quadratic Trend	-0.08*				19560.57	
Model 2	*n = 487*	*n = 59*				
Intercept	8.93	25.97				
Linear Trend	1.62*	4.55*				Model 1 vs 2
Quadratic Trend	-0.07*	-0.17*			19295.45	Δ = 265.12
Model 3	*n = 11*	*n = 128*	*n = 407*			
Intercept	23.72	21.688	7.31			
Linear Trend	4.10*	3.16*	1.54*			Model 2 vs 3
Quadratic Trend	-0.07	-0.12*	-0.06*		19189.19	Δ = 106.26
Model 4	*n = 415*	*n = 113*	*n = 10*	*n = 8*		
Intercept	5.68	29.92	22.35	4.18		
Linear Trend	1.93*	0.74	4.07*	17.94*		Model 3 vs 4
Quadratic Trend	-0.07*	-0.04*	-0.07	-0.71*	19108.31	Δ = 80.88

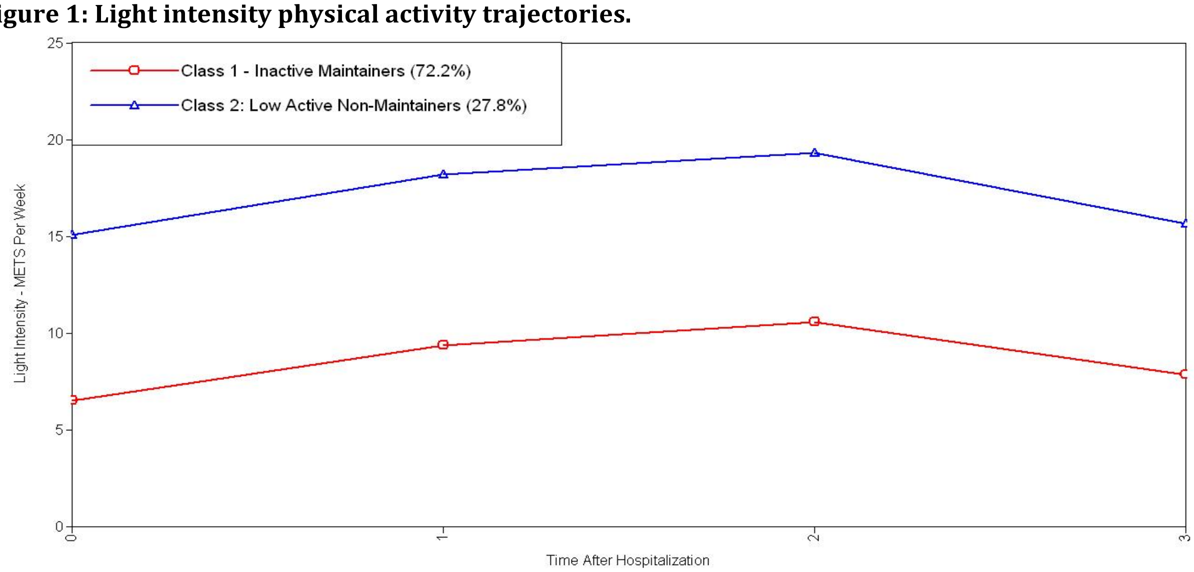
light intensity activity at baseline, however, the quadratic trend showed that the modest increase at 12 months also declined by two years. For moderate to vigorous PA, results also showed that two main classes emerged (i.e., Model 2 in Table 2). Again, the 3-class model showed a significant improvement in the BIC, however, the 2nd class had only 11 patients. Therefore, a 2-class model was used. Figure 2 represents the final LCGA, which showed that class 1 (i.e., *Inactive Maintainers – MVPA*) comprised 87.8% of the sample and were inactive for the 2-year duration regardless of the fluctuation in activity levels over time via the quadratic trend. The 2nd class of patients (i.e., *Active Maintainers – MVPA*) accounted for 12.2% of the sample and were active at baseline (i.e., their MET levels were > 24 for the week (Reid et al., 2006)), after which they followed a quadratic trend (i.e., there activity levels increased until 12 months after which they declined by two years).

Predicting Class Membership (Hypothesis #2): For light intensity activity, results from Table 3 showed that gender did not predict group membership. On the other hand, female patients (odds ratio = 3.94) were significantly more likely to be in class 1 for moderate to vigorous PA (i.e., *Inactive Maintainers - MVPA*) compared to males.

Discussion

The first objective of the current study was to identify potential subgroups that had distinct PA trajectories for light and moderate to vigorous PA over a two-year period after hospitalization for heart disease. In terms of light intensity PA, both the *Inactive Maintainers – Light* (i.e., 72.2%) and *Low-Active Maintainers – Light* (i.e., 27.8% of the sample) showed an increase in PA from baseline to 12 months, which was similar to the trend found in previous research with CABG patients(Jenkins et al., 1998). As such, evidence is accumulating to suggest that light intensity PA may increase up to one year after hospitalization for heart disease patients regardless of the PA measure and / or analytical approach used. More novel, however, is that

Figure 1: Light intensity physical activity trajectories.



regardless of which sub group the patients belonged to, their PA levels subsequently declined by two years after hospitalization. This emphasizes the importance of longer-term follow-up assessments with heart disease patients to more accurately reflect the PA sustainability issue for light intensity PA. Further, given the infancy of this research, replication is warranted using an objective PA measure (e.g., accelerometers), different samples (e.g., low income, rural, regional, etc.), and longer term follow-up (e.g., 5 or 10 yr).

With respect to moderate to vigorous PA, the majority of patients were *Inactive Maintainers* (i.e., 87.8%) for the entire 2-year period. Although their PA increased from baseline to 12 months and subsequently declined after that, their activity levels never reached the 24 METs per week guideline suggested for heart disease patients (Reid et al., 2006). On the other hand, the *Active Maintainers* (i.e., 12.2%) showed a similar trajectory pattern to the *Inactive Maintainers*; however, they met the 24 METs per week guideline at all four time points. For both groups, the increase in PA from baseline to 12-months was inconsistent with previous research, which showed a steady decline in moderate to vigorous PA from two to 12 months after hospitalization(Blanchard et al., 2007). However, this is likely due to differences in the PA measure used (e.g., the 7-day PAR: Blanchard et al., 2007) versus the LSI in the current study). Regardless, the current data and previous research (Blanchard et al., 2007) would suggest that the majority of this population need some form of a PA intervention to increase their PA levels after hospitalization. On the other hand, the current study suggests that only 12.2% of patients may need a relapse prevention type intervention at one year to ensure their PA levels do not decline. However, similar to light intensity PA, replication is warranted before any firm conclusions can be drawn.

Figure 2: Moderate to vigorous intensity physical activity trajectories.

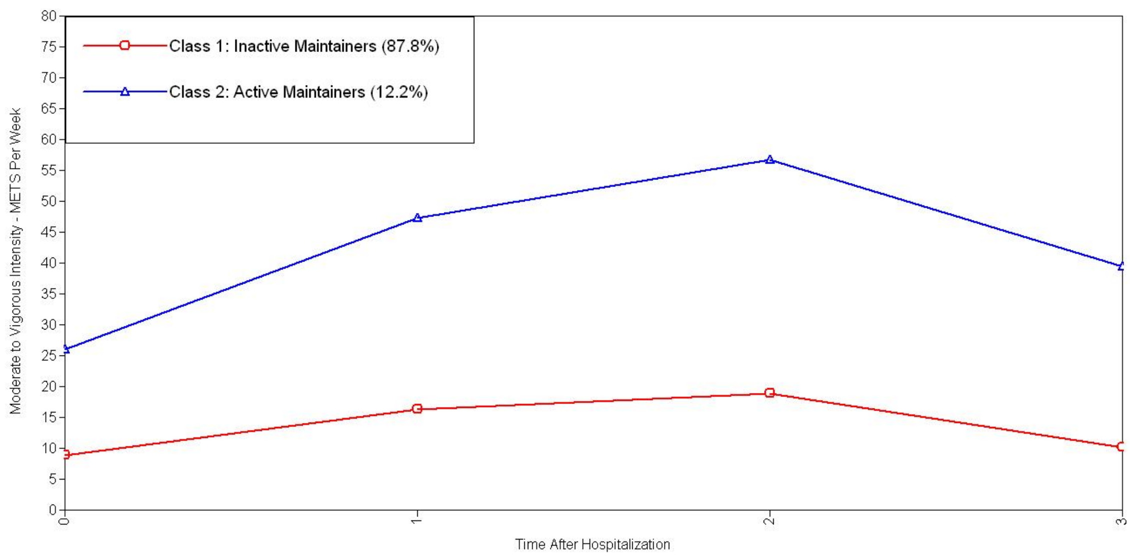


Table 3: Logistic regression results from the univariate and multivariate latent growth curve analyses predicting group membership (i.e., class 1 versus class 2) by physical activity intensity.

Patient Characteristics		Odds ratios predicting membership in Class 1 (Light Intensity)		Odds ratios predicting membership in Class 1 (MVPA Intensity)	
		Univariate	Multivariate	Univariate	Multivariate
Age	< 65 yr	1		1	1
	≥ 65 yr	0.95		2.64**	1.73
Education	< Grade 12	1		1	1
	≥ Grade 12	0.70		0.48*	0.56
Marital Status	Other	1		1	
	Married / common-law	1.60		1.34	
Employment Status	Not employed	1		1	1
	Employed	1.38		0.42**	0.73
Gender	Male		1		1
	Female		1.35		3.47*
Clinical					
Diagnosis–AMI	No	1		1	
	Yes	1.26		1.20	
Obese	No	1	1	1	
	Yes	2.08**	2.04**	1.01	
Comorbidities	0	1		1	1
	≥ 1	1.49		3.01***	2.32*

Note. * $p < 0.05$; ** $p < 0.01$; OR = odds ratio

The second purpose of the study was to determine if gender predicted group membership by intensity. As previous research for light intensity PA showed male CABG patients engaged in significantly more PA at one, two, six, and 12 months after hospitalization(Jenkins et al., 1998), it was hypothesized that gender would predict group membership. Unfortunately, this was not supported, although the trend indicated female patients were more likely to be in the *Inactive Maintainer – Light* group. Interestingly, both light intensity studies showed an increase in PA from baseline to 12 months using different samples and PA measures, however, in both studies, gender differences did not emerge. This may be partially explained by the fact that the PA trajectory we analyzed incorporated a two year follow-up period versus one year, the analytical differences between studies (e.g., independent sample *t*-tests versus LCGA), and the fact that we controlled for important covariates in our analyses (e.g., we found that obesity was a significant predictor of group membership) that were not accounted for in the other study. Whatever the case may be, there does not seem to be a consensus pertaining to the importance of gender from a light intensity PA perspective, which needs to be clarified in future studies.

From a moderate to vigorous PA perspective, results showed that female patients were 3.47 times more likely to be *Inactive Maintainers* compared to males. This finding is consistent with previous research(Blanchard et al., 2007) in heart disease patients not attending cardiac rehabilitation and reiterates the point that female patients are likely not getting the cardiovascular benefits of PA from a moderate to vigorous intensity perspective that the male patients are. This highlights the importance of developing PA interventions that target female patients to alleviate this gender discrepancy. Such interventions should be tailored to the needs of each gender and utilize important theoretical correlates of PA and behavioral change techniques to guide their development (Baranowski et al., 1998; Blanchard, 2012; Ferrier et al., 2011; Petter et al., 2009).

Despite the promising and novel findings of the current study, there are limitations that need to be considered. First, the present study used a self-report measure of PA, which may have resulted in the participants over or under-estimating the amount of PA they actually engaged in. Future studies should attempt to use accelerometers to obtain objective PA data and determine whether similar class trajectories would emerge for reach intensity. Second, a convenience sampling approach was used, which may have created bias in the sample (e.g., patients who were interested in PA may have been more likely to participate). Future studies should make efforts to alleviate this when possible.

In summary, the physical activity trajectories of heart disease patients vary as a function of PA intensity based on LCGA. Further, the importance of gender in predicting group membership was intensity-dependent (i.e., it predicted group membership for moderate to vigorous PA, but not light intensity PA). However, the reliance on self-reported PA and potential sample biases warrants replication in future studies before any firm gender discrepancies (or lack thereof) can be confirmed.

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Authors' Qualifications

The authors' qualifications are as follows: Chris M. Blanchard PhD, Robert D. Reid PhD, Louise I. Morrin PT, Andrew Pipe MD, and Ronald C. Plotnikoff PhD.

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