

# Impact of cardiology referral: clinical outcomes and factors associated with physicians' adherence to recommendations

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**OBJECTIVES:** Cardiology referral is common for patients admitted for non-cardiac diseases. Recommendations from cardiologists may involve complex and aggressive treatments that could be ignored or denied by other physicians. The purpose of this study was to compare the outcomes of patients who were given recommendations during cardiology referrals and to examine the clinical outcomes of patients who did not follow the recommendations.

**METHODS:** We enrolled 589 consecutive patients who received in-hospital cardiology consultations. Data on recommendations, implementation of suggestions and outcomes were collected.

**RESULTS:** Regarding adherence of the referring service to the recommendations, 77% of patients were classified in the adherence group and 23% were classified in the non-adherence group. Membership in the non-adherence group ( $p < 0.001$ ; odds ratio: 10.25; 95% CI: 4.45-23.62) and advanced age ( $p = 0.017$ ; OR: 1.04; 95% CI: 1.01-1.07) were associated with unfavorable outcomes. Multivariate analysis identified four independent predictors of adherence to recommendations: follow-up notes in the medical chart ( $p < 0.001$ ; OR: 2.43; 95% CI: 1.48-4.01); verbal reinforcement ( $p = 0.001$ ; OR: 1.86; 95% CI: 1.23-2.81); a small number of recommendation ( $p = 0.001$ ; OR: 0.87; 95% CI: 0.80-0.94); and a younger patient age ( $p = 0.002$ ; OR: 0.98; 95% CI: 0.96-0.99).

**CONCLUSIONS:** Poor adherence to cardiology referral recommendations was associated with unfavorable clinical outcomes. Follow-up notes in the medical chart, verbal reinforcement, a limited number of recommendations and a patient age were associated with greater adherence to recommendations.

**KEYWORDS:** Referral; Consultation; Audit.

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## INTRODUCTION

Consultation is the act of seeking advice regarding diagnosis and/or management (1). Consultation is a widely used practice in general hospitals and is an important part of a cardiologist's activities, constituting a substantial workload and demanding extra time and resources. Increases in life expectancy and advances in surgical and anesthetic techniques have allowed for surgical procedures to be performed in a broad population of patients, including

those with advanced age and multiple comorbidities. In these scenarios, anesthesiologists and surgeons often request preoperative consultations from cardiologists for patients with a high probability of perioperative complications. Furthermore, with the increasing complexity of patients' illnesses, cardiology consultations have become more frequent, even for patients with preexisting or suspected cardiovascular disease in a non-preoperative setting. Despite the importance of these factors, this topic has been poorly explored in the medical literature over the past few years.

Mackenzie et al. performed the first study specifically related to cardiology referral approximately 30 years ago. These authors examined 394 cases in a retrospective assessment of cardiology consultation activities, characterizing their effectiveness at a university hospital (2). The time spent since that study has involved many transformations in various aspects of cardiovascular medicine, guaranteeing

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the importance of new research in this area. More recently, a descriptive analysis of 136 requests to an inpatient cardiology consultation service was performed; however, this analysis was limited (3).

The effectiveness of cardiology referrals involves many variables, including knowledge of medical management and effective communication between the consultant and primary service. However, the effectiveness of cardiology referrals primarily depends on adherence to suggestions provided by the cardiology team. Moreover, the efficacy of referrals is associated with the clinical outcomes of the patients enrolled. Limited data exist on adherence to recommendations provided by cardiologists during solicited consultations and to our knowledge, no study has assessed whether patient outcomes differ according to adherence. In this prospective study, we aimed to determine whether physicians' adherence to the recommendations of solicited cardiology referrals was associated with better clinical outcomes. We also attempted to identify the factors associated with physicians' adherence to recommendations.

## METHODS

### Study design and setting

We conducted a prospective study of cardiology consultations solicited for adult inpatients at a university hospital in Brazil. The Interdisciplinary Medicine in Cardiology Unit (UMIC) of the Heart Institute (InCor) provides cardiology consultations to a tertiary hospital (Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo Medical School (HCFMUSP)). This service provides cardiology consultations to 2,500 medical and surgical patients per year on average and is performed by fourth-year cardiology residents who are supervised by attending cardiologists. All requests are emailed by the consulting service and are reviewed twice daily by the cardiology service. The consultations are performed from 08:00 AM to 5:00 PM Monday through Friday and the patients are seen within 24 h of submission of the request. A handwritten evaluation is placed in the patient's medical chart.

### Patients

All consecutive patients who received consultations and were referred to this service from March to September 2008 were examined. Patients who died, underwent operations, were discharged or were transferred within 24 h after submission of the request were excluded from the analysis. Patients younger than 18 years were also excluded. The remaining patients were included after providing written informed consent at enrollment.

### Data collection

Data were abstracted from the medical records by a physician-researcher (A.C.M.) who was independent from the doctors in charge of the patients. The abstraction included the following: clinical characteristics of the patients; the identity of the service requesting the consultation; the reason for consultation; medical diagnoses already established and additional diagnoses discovered by the consultant; characteristics of the consultation process; characteristics of the recommendations, including the number, type and complexity of suggestions; adherence of the primary service to the recommendations offered by the

consultant; and clinical outcomes. Adherence was assumed if there was evidence on the patient's medical chart that the recommendations had been followed within the specified time or within 72 h if no time was specified. Based on a protocol described in the literature, we classified patients according to the percentage of accepted suggestions into an adherence group ( $\geq 85\%$  of suggestions accepted) and a non-adherence group ( $< 85\%$  of suggestions accepted) (4).

An important clinical characteristic, the severity of patients' illnesses, was evaluated using the Charlson comorbidity index (CCI), a validated method for classifying comorbidities to predict short-term and long-term mortality from medical records (5). The CCI has been successfully used with laboratory and clinical data as a risk-adjustment approach.

Regarding the characteristics of the consultation process, personal communication with the primary service was defined as verbal reinforcement given by the physician-researcher to the referring physician regarding suggestions that were written in the medical chart. Deliverance of verbal reinforcement (yes or no) was alternatively performed to the patients in the consultation list. The timing of the response was defined as the time between the date the consultation was received in the mailbox and the date when the first note was recorded in the medical chart. Finally, the complexity of recommendations was arbitrarily defined and categorized into three levels: high (cardiac catheterization with or without angioplasty, cardiac surgery, pacemaker implantation, invasive hemodynamic monitoring, endotracheal intubation, electrical cardioversion, endomyocardial biopsy) intermediate (vasoactive drugs, blood transfusion, full anticoagulation, transesophageal echocardiography, noninvasive tests for myocardial ischemia, computed tomography pulmonary angiography, transfer to the intensive care unit (ICU), intravenous antiarrhythmic drugs) and low (recommendations involving other noninvasive exams and medications).

### Data analysis

Predictors of adherence to recommendations were analyzed in all cases, including clinical and preoperative evaluations. However, an analysis of clinical outcomes was performed only in cases involving patients receiving clinical assessments and did not include patients receiving preoperative evaluations. This decision was made due to the expected difficulty in monitoring patients receiving preoperative evaluations, as an analysis of the clinical outcomes of these cases would require an active search for perioperative events with complementary tests for a large number of patients with different surgical complexities. This could generate some selection bias and jeopardize the data analysis.

Therefore, data from patients undergoing preoperative evaluations were collected until the time of surgery. Patients receiving clinical evaluations were followed up until the end of cardiology referral, which was jointly determined by the team of cardiologists and the staff requesting the referral, regardless of the patient's stay in the hospital as determined by the primary team. At that time, the clinical outcome was analyzed.

In the clinical outcome analysis, the patients were categorized into the following groups: hospital discharge, death, clinical improvement, no clinical change, or clinical worsening. Objective data (hospital discharge and death)



were obtained from the medical records. Conversely, subjective data (clinical improvement, no clinical change or worsening) were obtained from the two medical residents involved in the case — the requester and consultant — using a Likert scale, with scores ranging as follows: -2 (much worse), -1 (worse), 0 (unchanged), +1 (improved) and +2 (much improved). The clinical outcomes were characterized according to the sum of the scores corresponding to the responses of the two residents involved in each case, including clinical worsening (-1 to -4), no clinical change (0) and clinical improvement (+1 to +4). To reduce possible bias in the responses, the residents were not informed about the purpose of the study. Thereafter, patients who experienced clinical worsening or death were classified into the unfavorable outcomes group, whereas the remaining patients were classified into the favorable outcomes group.

### Study outcomes

Our primary study outcome was to determine whether physicians' adherence to recommendations from cardiology referrals (adherence group *vs.* non-adherence group) was associated with unfavorable outcomes. Furthermore, we aimed to identify variables that were correlated with adherence to recommendations.

### Sample size calculation

A pilot study that was conducted by our group at the same hospital evaluated 300 cardiology referrals, of which 75% were classified into the adherence group. This study demonstrated a 43% reduction in unfavorable outcomes (clinical worsening or death) in patients in the adherence group (6.3% of events) compared with patients in the non-adherence group (11.1% of events) (4). Based on these data and to obtain a statistical power of 80% to detect a 10% difference between groups, it was estimated that the sample size needed was 201 patients in the adherence group and 67 patients in the non-adherence group. The same ratio between the groups was found in the pilot study (3:1) with a significance level of 0.05 (two-tailed).

### Statistical analysis

All the analyses were performed using SPSS PASW statistical software, version 18. Descriptive statistics are presented as numbers and percentages for categorical variables or medians and interquartile ranges for continuous variables. Differences in characteristics according to adherence to cardiology recommendations and clinical outcomes were compared using the chi-squared test for categorical variables and the Mann-Whitney U test for continuous variables.

To identify independent predictors of clinical outcomes and adherence, we developed a logistic regression model by entering variables with a *p*-value less than 0.10 and variables that were non-significant but biologically relevant in a bivariate analysis. In the multivariate analysis, a *p*-value less than 0.05 (two-tailed) was used to identify variables that were independently correlated with clinical outcomes and with adherence to cardiology recommendations.

### Ethics statement

All patients included in the study provided written informed consent at enrollment and the local ethics committee approved the protocol (CAPPesq - Comissão de

Ética para Análise de Projetos de Pesquisa do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo - HCFMUSP).

## RESULTS

Among the 806 consecutive inpatient referrals over the 7-month study period, 217 were not included in the analysis according to the established criteria. Therefore, 589 consultations were selected for the study.

The baseline characteristics of the patients and consultations are summarized in Table 1. The median age for all the patients was 64 years (interquartile range, 54-72 years). We observed a higher percentage of men (56%) than women. The median hospital duration was 21 days and the median severity index (CCI) was 3. Approximately 10% of patients were in the ICU. Notably, a previously unsuspected cardiovascular diagnosis was discovered in 194 cases, representing 33% of the cohort.

The primary reason for requesting an inpatient cardiology consultation was preoperative evaluation, representing 54% of referrals. Surgical specialties were the most frequent requesting services, particularly vascular surgery, which represented 19% of consultations. The cardiology service made 1,920 recommendations, with a median of two (1-23) recommendations per consultation. Most suggestions were defined as low-complexity recommendations. Recommendations involving medications accounted for 66% of all recommendations, followed by those involving noninvasive exams/monitoring (28%) and invasive procedures/interventions (6%).

Regarding adherence of the requesting service to the recommendations, 454 consultations (77%) were classified

**Table 1 - Characteristics of patients and consultations selected for the study.**

Patient characteristics	
Age, years – median (IQR)	64 (54-72)
Sex – N (%)	
Male	328 (56)
Female	261 (44)
Severity of patients' illnesses: CCI – median (IQR)	3 (2-4)
Patients in the ICU – N (%)	56 (10)
Length of hospital stay, days – median (IQR)	21 (12-34)
Referring service – N (%)	
Surgical	420 (71)
Non-surgical	169 (29)
Consultation characteristics	
Number of recommendations per consultation – median (IQR)	2 (1-4)
Timing of response, hours – median (IQR)	24 (10-24)
Consultations with follow-up visits – N (%)	255 (43)
Consultations with a new cardiovascular diagnosis – N (%)	194 (33)
Consultations with personal communication – N (%)	295 (50)
Type of consultation – N (%)	
Preoperative	318 (54)
Non-preoperative	271 (46)
Type of recommendation – N (%)	
Medication	1256 (66)
Noninvasive exams/monitoring	546 (28)
Invasive procedures/interventions	118 (6)
Complexity of recommendations – N (%)	
Low	1592 (83)
Intermediate	211 (11)
High	116 (6)

IQR: interquartile range; CCI: Charlson comorbidity index; ICU: intensive care unit.



in the adherence group and 135 consultations (23%) were classified in the non-adherence group. According to this classification, a bivariate analysis was performed with the variables collected and adherence to cardiology consultation (Table 2).

The multivariate analysis identified four independent predictors of adherence: the presence of follow-up notes in the medical chart; verbal reinforcement; the number of recommendations and the patient's age (Table 3). Neither the referring service nor the severity of patients' illnesses nor the type or complexity of the recommendations affected adherence to the recommendations.

An analysis of clinical outcomes was also performed in 271 patients who were not scheduled for preoperative evaluations. Of these patients, 105 (37.8%) were discharged, 20 (7.4%) died, 17 (6.2%) experienced clinical worsening, 72 (26.5%) experienced clinical improvement and 60 (22.1%) experienced no clinical change.

For the subjective data collected using the Likert scale from the two medical residents involved in the case, Spearman's correlation coefficient ( $\rho$ ) for the responses was 0.856, with  $p < 0.001$ .

The relationships between the variables (including adherence to recommendations) and the clinical outcomes of the patients were investigated. This analysis considered unfavorable (death or clinical worsening) or favorable (discharge, clinical improvement or no clinical change) outcomes. In an initial analysis, there was a significant association between the non-adherence group and an unfavorable clinical course (Figure 1).

After performing a logistic regression, membership in the non-adherence group and advanced age were identified as independent predictors of unfavorable clinical outcomes (Table 4). After the multivariate analysis, clinical outcomes were not affected by the referring service, the presence of patients in the ICU or the achievement of new cardiovascular diagnoses.

**Table 3 - Independent predictors of adherence to cardiology consultation recommendations after logistic regression.**

Predictor	Adjusted OR (95% CI)	p-value
Follow-up visits	2.43 (1.48-4.01)	<0.001
Verbal reinforcement	1.83 (1.23-2.81)	0.003
Number of recommendations	0.87 (0.80-0.94)	0.001
Patient's age	0.98 (0.96-0.99)	0.002

OR: odds ratio; CI: confidence interval

**DISCUSSION**

In this prospective analysis of inpatient cardiology consultations, we found an overall adherence rate of 77%, which was associated with clinical outcomes. Although consultation is an important feature of cardiology practice, limited data exist regarding how requesting physicians comply with solicited recommendations and how this adherence affects clinical outcomes.

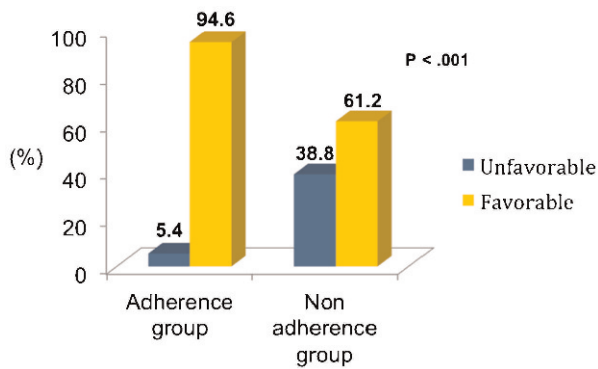
Interesting clues can be derived from the descriptive analysis of the data in this study, which evaluated the effectiveness and efficacy of cardiology consultation. First, the long hospital stays and the high value of the severity index might reflect the greater complexity of the cases involving patients requiring cardiac care. Surgical specialties, because of the need to evaluate surgical risks, require more frequent cardiology consultations than clinical specialties. Among surgical specialties, vascular surgery teams, which care for patients with significant atherosclerotic disease who undergo higher-risk operations, were the most frequent requesting service.

A remarkable finding of the present study was that in approximately one-third of cases, the cardiology team provided a new diagnosis that was not provided by the service requesting the referral. The discovery of unsuspected but clinically important medical problems is an

**Table 2 - Bivariate analysis of individual predictors and adherence to recommendations.**

Predictors	Adherence group (N = 454)	Non-adherence group (N = 135)	p-value
Age, years – median (IQR)	62 (52-71)	67 (58-76)	<0.001
Male sex – N (%)	258 (56)	70 (52)	0.30
Severity of patients' illnesses: CCI – median (IQR)	3 (1-4)	3 (2-4)	0.44
Patients in ICU – N (%)	37 (8)	19 (14)	0.03
Length of hospital stay, days – median (IQR)	21 (12-33)	23 (13-36)	0.20
Type of consultation – N (%)			
Preoperative	250 (55)	68 (50)	0.34
Non-preoperative	204 (45)	67 (50)	
Referring Service – N (%)			0.02
Surgical	313 (69)	107 (79)	
Medical	141(31)	28 (21)	
Number of recommendations – median (IQR)	2 (1-4)	3 (2-5)	<0.001
Timing of response, hours – median (IQR)	24 (10-24)	24 (8-24)	0.78
Consultations with follow-up visits – N (%)	205 (45)	50 (37)	0.09
Consultations with a new cardiovascular diagnosis – N (%)	139 (31)	55 (41)	0.02
Consultations with verbal reinforcement – N (%)	245 (54)	50 (37)	0.001
Type of recommendation – N (%)			0.14
Medication	882 (65)	374 (67)	
Noninvasive exams/monitoring	393 (29)	153 (28)	
Invasive procedures/interventions	92 (6)	26 (5)	
Complexity of recommendations – N (%)			0.58
Low/Intermediate	392 (86)	119 (88)	
High	62 (14)	16 (12)	

IQR: interquartile range; CCI: Charlson comorbidity index; ICU: intensive care unit.



**Figure 1** - Association between adherence to recommendations and clinical outcomes.

important benefit of medical consultation. Thus, medical consultation has the potential to provide additional preventive and therapeutic measures.

**Predictors of adherence to recommendations**

The overall compliance rate of 77% was consistent with the findings of Mackenzie in the first study on cardiology consultation (2). To improve the effectiveness of cardiology referrals, identifying the factors that are correlated with compliance to recommendations is essential. The regression analysis revealed that adherence depended on the presence of follow-up notes in the medical chart, verbal reinforcement of recommendations, the number of cardiology suggestions and the patient’s age.

The hallmark of successful cardiology consultation is effective communication with referring physicians (6). It is apparent that variables representing effective communication (follow-up visits and verbal reinforcement) are the most important in explaining variations in case concordance. According to our findings, follow-up contact occurred in 43% of cases and was found to be the most important predictor of adherence. Previous studies have also found that the presence of a follow-up note in a patient’s medical chart was associated with a higher rate of adherence (2,7). Frequently, the question that motivated the consultation was not clearly communicated by the primary physician; alternatively, the question was overlooked by the consultant (6). Rudd et al. found that no specific question was asked in 24% of consultations for diabetic patients and that consultants ignored explicit questions in another 12% of consultations (8). The follow-up visits and personal communication provide the opportunity for contact among the medical staff, clarifying possible questions and enabling a greater acceptance of suggestions by the requesting team. Successful cardiology consultation depends not only on the knowledge of medical management but also on effective communication between cardiologists and their colleagues in other disciplines. Direct contact can prevent

**Table 4** - Independent predictors of unfavorable clinical outcomes after logistic regression.

Predictor	Adjusted OR (95% CI)	p-value
Non-adherence group	10.25 (4.45-23.62)	<0.001
Patient’s age	1.04 (1.01-1.07)	0.01

OR: odds ratio; CI: confidence interval

communication problems and reduce delays in initiating appropriate care (9).

In a series of 202 general medicine consultations, Sears and Charlson found that adherence was greatest when five or fewer recommendations were made, despite the severity of illness (10). In our analysis, fewer recommendations were also identified as a predictor of acceptance, suggesting that objectivity and a direct approach are important and that long written descriptions are unlikely to be read. Although patient cases requiring cardiologic care are more complex and involve more problems to solve, the focus should be on essential issues related to current patient care. The consultant’s advice and recommendations must be concise and specific to the questions asked by the requesting physician (11). An inverse relationship between the number of recommendations and adherence has also been observed in other studies (2,12).

Interestingly, the patient’s age was also inversely associated with adherence to recommendations. Older patients tend to have poorer prognoses than younger patients, resulting in a more conservative approach by requesting physicians. Specifically, the referral of older patients was associated with a lower rate of acceptance of recommendations. Although statistically significant, this association (OR: 0.98; 95% CI: 0.96 to 0.99) did not have the same strength as that observed with other predictor variables, suggesting that age has only minor importance in explaining the variation in adherence to recommendations.

**Predictors of clinical outcomes**

To our knowledge, this was the first study to examine the relationship between adherence to recommendations in cardiology referrals and patients’ clinical outcomes. After the multivariate analysis, an association was demonstrated between lower adherence to cardiology recommendations and unfavorable clinical outcomes (death or clinical worsening) of patients involved in cardiology referrals.

It is possible that the outcomes of patients with diseases that directly or indirectly affect the heart are more favorable with the support of a cardiologist. Medical knowledge in various areas has developed in an accelerated fashion, complicating the management of certain diseases by general practitioners. Although the roles of general practitioners and specialists have been subject to debate, some studies have shown that patients with certain diseases treated by specialists have better outcomes than those treated by generalists.

Jollis et al. retrospectively studied more than 8,000 patients admitted for acute myocardial infarction (AMI) to hospitals in the United States and compared the mortality rates between patients attended by cardiologists and those attended by generalists. The analysis demonstrated that the mortality rate of patients with AMI assisted by cardiologists decreased by 12% within one year. Cardiologists frequently use invasive procedures and medications that have been proven to increase the survival of these patients, which could explain the findings of the study (13). A similar analysis involving more than 88,000 patients admitted with AMI in England and Wales showed that the mortality rate of patients assisted by cardiologists was 14% lower than that of patients assisted by generalists within three months. In that study, reperfusion therapy through fibrinolysis or primary angioplasty was more frequently used in patients managed by cardiologists (14).



Similarly, in 2000, Go et al. published a systematic review of studies that analyzed the effects of medical specialists on the treatment of patients in the United States with coronary artery disease and heart failure. In that analysis, the authors demonstrated that these patients had a greater chance of receiving appropriate treatment if they were treated by cardiologists (15).

As expected, age, which is a risk factor and marker of severity for several diseases, was also associated with unfavorable outcomes in the present analysis.

Although it did not reach statistical significance in the logistic regression model, the Charlson comorbidity index showed a trend toward association with unfavorable clinical outcomes in our sample (odds ratio: 1.18;  $p=0.073$ ). It is possible that this variable would reach statistical significance with a larger sample.

## ■ STUDY LIMITATIONS

The present study had some limitations. It was conducted at a single university hospital in Brazil; thus, the results might not be generalizable to other settings. Despite attempts to minimize the problems related to the use of subjective data in the primary outcome with an objective tool (Likert) and despite the strong correlations among the data, we cannot exclude bias from the analysis of clinical outcomes.

The requesting physicians were not asked about the reasons for non-adherence to recommendations. Moreover, the content of the recommendations was not evaluated to observe their agreement with the guidelines. However, the association between non-adherence to the suggestions and unfavorable outcomes suggests that adherence to recommendations is associated with better quality of care.

Finally, despite the adjustments made by the multivariate analysis, the observational nature of the study implies the possibility that confounding factors, unmeasured or unknown, might have influenced the results.

## ■ CLINICAL (AND TRAINING) IMPLICATIONS

Cardiologists spend a large percentage of their time providing consultations. Furthermore, cardiology consultations frequently encompass complex medical problems and life-threatening situations, knowledge of which is essential in cardiology training. Most physicians learn their consultative skills during various rotations as medical residents. Training programs in cardiology more frequently include rotations in cardiology consultation services to provide each resident with experience in this aspect of clinical practice. Although there has been a paucity of data concerning this issue, its importance should not be underestimated in cardiology training programs.

In summary, non-adherence to recommendations given during cardiology referrals was associated with unfavorable

clinical outcomes (clinical worsening or death) of the patients involved. Follow-up visits, verbal reinforcement, number of recommendations and the patient's age were identified as factors that were correlated with adherence to cardiology referrals.

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## ■ AUTHOR CONTRIBUTIONS

All authors have significantly contributed to the execution of the project and approved the final version of the manuscript. The manuscript was written by Marques AC and Caramelli B.

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