An Acad Bras Cienc (2022) 94(Suppl.1): e20210396 DOI 10.1590/0001-3765202220210396
Anais da Academia Brasileira de Ciências | *Annals of the Brazilian Academy of Sciences*
Printed ISSN 0001-3765 I Online ISSN 1678-2690
www.scielo.br/aabc | www.fb.com/aabcjournal

SOCIAL SCIENCES

Mapping research paths and perspectives over the fieldwork of human physiology in Antarctica: reflections on the integration of science, environment, and subjectivity

ALICE L. MARQUES, MICHELE M. MORAES & ROSA M.E. ARANTES

Abstract: We summarize and elaborate on the challenges of researching in the field of human health in Antarctica based on the conceptual and methodological specificities of a line of investigation that aims to study the human presence in Antarctica in all of its dimensions (biological, psychological, and socio-anthropological). Herein, we discuss the principal results and limitations of the research carried out by researchers of MEDIANTAR (Antarctic medicine, physiology, and anthropology) group of Programa Antártico Brasileiro in isolated, confined, and extreme environments over the last six years. Fieldwork has been carried out in remote research camps, Brazilian navy ships (Almirante Maximiano/H-41 and Ary Rongel/H-44), and Comandante Ferraz Antarctic Station. Adaptative responses to isolated, confined, and extreme environments were studied based on questionnaires, interviews, participative observation, biological samples, anthropometric, and physiological parameters. Our researchers face the unique situation of concomitantly working under the stressful living conditions that are the object of their investigation. A critical examination of the socio-methodological characteristics and challenges of this research niche indicates the need for exchanging the lessons learned and limitations of these practices with researchers in the humanities field, with attention to the human resources needs in multidisciplinary human-related studies.

Key words: confined, extreme (ICE) environments, health Anthropology, human biology, humanities, isolated.

INTRODUCTION

Antarctica, the most isolated and extreme continent of the world, offers a unique opportunity to investigate relevant aspects of human physiology, psychology, and sociology (Roberts et al. 2016). As a research group of the Brazilian Antarctic Program (Programa Antártico Brasileiro – PROANTAR) studying the human presence in Antarctica over the last six years, we propose reflecting on anthropological, psychological, and physiological research in Antarctica (COMNAP 2021a). We summarized and elaborated on the challenges of researching human health in Antarctica, taking as a starting point the experience with the measures of physiological variables during fieldwork, under the guidance of the socio-anthropological perspective, and pointing to the need to understand the human presence in Antarctica in all of its dimensions.

The inexistence of native populations, the geographical distance from densely populated regions, and the original difficult access to the icy continent respond to the Antarctica narrative, as a distant and inhospitable local (COMNAP

2021b). The Antarctica consolidated image links it to space, devoid of local human life and social organization, allocating the dimensions of limited social dynamic situated in second place in scholar agendas (Harrison et al. 1989).

This scenario has been changing, especially since the signing of the Antarctic Treaty in 1959 (Wolak & Johnson 2021). This era consolidated the continent as a place destined for preservation and scientific research and encouraged paradigm breaks, including that Antarctica does not allow women's presence. Then, new Antarctic portraits emerge, like Werner Herzog's film Encounters at the End of the World (2001), Juan Salazar's documentary Nightfall on Gaia (2015), the Brazilian fiction movie Soundtrack (2017), and the recent and intensive coverage on media on the inauguration of the new Brazilian Scientific Station (2020) (Jeantet 2021). Not only penguins and receding cryosphere plaques the continent is made of. On the contrary, Antarctica is constituted progressively as a humanized environment. The scientific activities based in the field of islands, the wintering in the stations, and the logistical investments for the preservation and surveillance of the Continent are precisely what constitutes Antarctica in its correlation with Humanities. The scope of local activities in the Antarctic field acts as an interlocutor between the environment and human life, bringing humanity to the continent.

It is in the interlocution and interaction of individuals with the environment, in activities based on ships, stations, and camps, that human biology/physiology finds its object of study. It is worth noting that these environments are defined as ICE (isolated, confined, and extreme), where isolation from friends and family, situations of confinement, and extreme conditions combine. These characteristics inscribe ICEs as "space-analogs" (Golden et al. 2018, Van Ombergen et al. 2021), i.e., environments on Earth that simulate aspects found in space missions. Depending on the permanence and activities to be developed in Antarctica, human groups - research, logistical support (civil or military) - can deal with different magnitudes of ICE's physical and psychological risks, difficult working conditions, and stressors to human homeostasis (Van Ombergen et al. 2021). Permanence on ships and at research stations, generally ranging from months to a year, imposes isolation, confinement, and extreme light conditions (low light, especially in winter). However, it is during long-term camps fieldwork that individuals most directly face the natural environment of Antarctica.

Physiologists seek to understand the effects of the Antarctic environment on physiological responses and the ability to adapt to these demands — i.e., acclimatization, the physiological changes occurring within an organism, which reduce the strain caused by stressful natural environment conditions (Glossary of terms for thermal physiology 2003). During permanence in summer camps, the extreme Antarctic environment is composed of high luminosity and radiation incidence, low thermal sensation (due to cold and wind), and occurrences of storms and white-out situations, associated with physical demand due to long trips on rugged and snow-covered terrain (Moraes et al. 2018, Mairesse et al. 2019, Pattyn et al. 2017, Sandal et al. 2006). This stressful natural environment and social ICE conditions induce physiological and behavioral changes, as in hormonal autonomic nervous system, mood states, and sleep patterns (Moraes et al. 2018, 2020, Mairesse et al. 2019, Pattyn et al. 2017, Palinkas & Suedfeld 2008, Palinkas et al. 2007, Sandal et al. 2006, Harinath et al. 2005). Stress increases anxiety, social impairment, cognitive load, and negative emotions while decreasing attentional focus (Driskell & Driskell 2015). Therefore, the individuals who move and remain in Antarctica

are physically and emotionally affected; however, defies and frequent stressors arising from ICE dimensions may give rise to unique patterns and an unparalleled opportunity to study coping.

Although different research groups worldly move towards Antarctica to investigate psychophysiological variables, there is a lack of reflections on the research process in this peculiar field. Researchers in biopsychosocial knowledge areas, as physiologists, experience the unique situation of facing challenging work and stressful living conditions at ICE while realizing their fieldwork investigating the demanding activities and stressful ICE living conditions of a group of researchers. Possible this particular condition of study has not yet been noticed because, compared to the most traditional scientific research area covered in Antarctic Programs, the research in human biology, physiology, and medicine is under-represented, reducing the visibility of this work.

Besides, it is worth mentioning that investigation about the research process (i.e., in this specific case, the human biology, physiology, and medicine research process) demand an anthropological perspective, which is dependent on the entry of areas of knowledge in Antarctic humanities and social sciences.

An Antarctic Humanities is inseparable from the representations selected, distilled, and packaged by humans, whether imagining or living in Antarctica, even temporarily (Roberts et al. 2016). From recent decades, critical currents have emerged from social sciences and anthropology of medicine, calling for an examination of conceptualization of health (Napolitano & Jones 2006). Biomedical and social scientists should work critically towards a research practice that draws as much from humanities as biomedicine to improve Antarctica population health by moving from a disease-focused approach to a socio-cultural one.

Therefore, research on the biopsychosocial human dimensions of Antarctic ICE, which is already pulverized across disciplines, also needs a diverse logistical and cultural approach. The anthropological view of the field research in human biology is an interpolation of areas and experiences, allowing the construction of a new data set for understanding the human dimensions in Antarctica (and beyond ICE).

Herein, we discuss our experience in the human biology research field critically examining the methodological characteristics, limitations, and challenges of this niche practice. We offer insights for the research training and approach to work with extreme volunteers (e.g., military, medical, police, fire), also incorporating the humanities and social science perspectives. Rather than shying away from the challenges, we need to rely on complementary approaches leveraging extensive pre-planning, basal pre-field data collection, guided and unstructured individual interviews, ethnographic methods, questionnaires, post-event interviews/sample collections, and adapting our techniques and equipment.

Further, researchers within the extreme human biology research field should exchange the lessons learned and the best practices accessing samples in ICE environment, and the limitations of these practices towards a new integrative view on human-related research. Using mixed methods is possible to bridge physical and cultural determinants of Antarctica health and physiological adaptation. Studying the influences of cultural experiences and body habitus in illness development, cognitive, mood, sleep disorders, and acclimatization would allow the implementation of multidisciplinary studies combining physiology, psychology, and humanities (Paoletti et al. 2021).

We recognize that the quantitative projects provide mechanistic evidence for developing innovative prevention and intervention strategies. However, advances in health-related research themes are better achieved if research efforts reach the socio-context of these strategies. We believe that this approach provides realistic targets for culturally appropriate disease prevention and health management (Tenny et al. 2021).

MATERIALS AND METHODS

Anthropological assessments

The discussion of the present work is based on (i) the group's fieldwork throughout expeditions within the Brazilian Antarctic Program and through participant observation (during XXXIV and XXXVIII Brazilian Antarctic Operations/PROANTAR (along 50 days) (for groups characteristics, see Figure 1) [experimental procedures were approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (protocol certificate numbers 19092819.8.0000.5149, 56360516.5.0000.5149)]; (ii) ethnographic observation of physiological data collection pre and during Antarctic Camp (XXXVIII Brazilian Antarctic Operation/PROANTAR); and (iii) literature review on the concepts: Being affected (Favret-Saada 1990), Obviation (Ingold 2015, 2016), Biopsychosocial body, and embodiment (Bonet 2014, 2015, Csordas 2008), adopted as theoretical references.

RESULTS AND DISCUSSION

Conducting any research in Antarctica is challenging (Bell et al. 2018). Antarctic research demands extensive planning months/years in advance, including logistic details and searching for suitable materials. Especially for research conduction in camps, data collections demand equipment that does not depend on the internet, with long energy autonomy, portable and weather resistance.

Collecting human biological materials involves Antarctica's ICE hurdles and, like specificity, presents dependence on the volunteering of the military personnel, the Research Stations and Ships staff, or the scientists that work in Antarctica (for details on the descriptive longitudinal approach adopted by the group, see Figure 1). These demands include prior approval by an ethics committee, planning the data-collection intent points, and early contact with potential volunteers. Also, the research usually demands long-term follow-up, covering pre-and post-examinations of the volunteers (which may not be feasible due to expeditions sometimes being composed by individuals from different regions of a country and even from diverse countries). In addition, the possible unforeseen events in a field collection, both with researchers who collect biological data and any events that affect their group of volunteers or an individual, may demand to adapt planned measures and experimental designs along the expedition.

Despite the opportunity to realize robust lab studies that can mimic extremity, these studies are very impactful when combined with an interview, survey, or observational field study of teams in the extreme. Thus, cold, isolation, and confinements are variables studied and embodied in the work process itself.

Regarding the environment, at least two points emerge that affect the methodological practice in Antarctic expeditions. The conceptualization of participant observation is widely known among anthropologists and has gained support as an effective practice for obtaining data in the humanities. Unlikely anthropologists, physiologists may not have

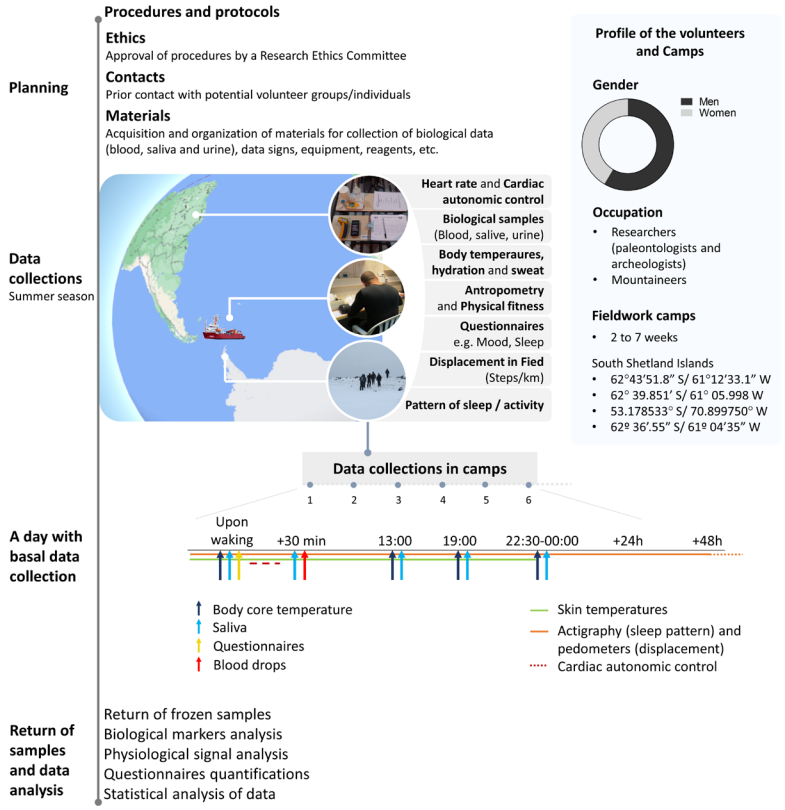

Figure 1. Overview of human biology-research methods in Antarctica. Milestones of a data collection. (i) *Planning*; including approval by a Research Ethics Committee. The volunteers are informed about the objectives and experimental procedures and are free to decide, at any time, not to participate in any procedure or the entire data collection without providing explanations. (ii) The locations for *data collection* in the summer period in Antarctica; data collection occurs in Antarctic field period and, when possible, in pre-and post-field moments on the ship, or even in laboratory-controlled environmental conditions in Brazil (15 to 30 days before the expedition and after return). For the participants' physical characterization, anthropometric characteristics are usually evaluated. We performed collections of biological samples (e.g., blood, saliva, and urine), cardiac autonomic control measures, temperatures, and mood states using questionnaires. To assess physical fitness, incremental tests to estimate aerobic capacity are conducted on the ship (to estimate their $\mathring{V}O_{2MAX}$ and to assess HR at submaximal intensities) or in laboratories in Brazil (by direct measure of $\mathring{V}O_{2MAX)}$ (for detailed technical protocols, see Moraes et al. 2018, 2020, 2021, Martins et al. in press). (iii) Timeline representing *a day with basal data collections* in Antarctica; the collections of biological materials occur in the morning and, if necessary, at other time points of the day. Also, morning resting heart rate variability measures are obtained to assess autonomic control. To assist in the understanding of the variables, the participants are asked to answer a mood questionnaire. We also accompany the volunteers over field activities, during which we evaluate the intensity of effort and thermoregulatory responses, and monitor the daily displacement of the participants. For thermoregulatory monitoring, we measure skin temperatures by contact sensors attached to the participant's body and by infrared thermometer for the skin exposed area (i.e., face). However, a defy is the measurement of internal temperature. A practical and wireless method that allows monitoring the internal temperature while working in the field for long hours is the use of ingestible capsules for measurement by telemetry. We performed this measure in fieldwork camps on individuals who had previously ingested a capsule in Brazil. To these methods previously used in the aforementioned works, others were added (results not yet published), such as the measure of the activity pattern over 24 hours, to evaluate the sleep/wake cycle, by actigraphy (a clock-shaped device) throughout the measurement period. (iv) After data collection and *return of samples and data analysis*, samples and data are processed considering fieldwork's specific conditions. The number of volunteers in camps varied between 7 to 10 [8.2 ± 1.3 (average data and standard deviation)]. Of these, 41.5% of the participants were women [in each camp, the number of women varied from 30 to 62% (including data not yet published)].

specific training to interact subjectively with their volunteers. The situation of an expedition demands what Fravet-Saada (Fravet-Saada 1990) called the "capacity and openness to the process of field assignment". Although long immersion experiences in research fields may be usual, the experience of confinement and isolation in the Antarctic field implies immersion in an environment in which weather events and confinement restrains are decisive conditioning factors to the detriment of the self-determination of individuals.

Local environmental events may be very restrictive to the conduction of the research. These conditions challenge the researcher to remain healthy in the field, and in some cases, may even restrict reaching the places to be visited. On the other side, these weather conditions are exactly the extreme environmental scenario in which the research volunteers will perform and present their physiological reactions to be measured and investigated. One can say, in this case, that the existence of the research and the researcher himself, in physical-pathological and subjective terms, are at stake in the work.

The researcher, thus, does not go to the field, observes, registers, and returns to his office with a notebook systematically organized, but remains living and researching, simultaneously, under socially tensioned situations, inhospitable in most cases and unfavorable logistic conditions. In this sense, to be in and resist the conditioning of the Antarctic environment starts by validating that weather and climate measure the movements in Antarctica, which allow them or restrict them. Taking up the points brought by Favret-Saada, the researcher must enter Antarctica as a partner and invest the dimensions of his existence (Fravet-Saada 1990) in the field activity.

This discussion should be taken into Antarctic educational programs for training researchers because even if objective data are obtained, a rich subjective experience of the researcher also needs to be scored and reported. This experience could be incorporated and reversed in research protocols, which aim at better data collection and analysis methodologies, similar to other research fields (Golden et al. 2018).

Another point is conceptual of what human physiology may signify in its practice. It says that research in human biology of extreme environments, as a process and research object, is also related to what became known as 'the embodiment as a conceptual and technical paradigm´. For Csordas (2008), when *our/their* bodies - referring to volunteers in Antarctica -, are apprehended from what it experiences, not as a research subject itself, the distinction between body-mind or culture and biology starts to be questioned.

The centrality of corporeality in cultural studies in the theory of Csordas (2008) leads to delineating the processes of health and illness as a domain socially constituted in the field of extreme medicine. Sensory expressions, including experiences of the maladies, are shared and significantly infiltrate cultural modes. Experiences of the illness are part of the social construction. The social construction of the illness is an important research perspective in medical sociology, not well explored in Antarctica.

Illnesses, health, and physical and emotional well-being are embedded with cultural meaning and not exclusively derived from the conditioned nature. The corporeality/body concerning the ambiance conforms apparatuses for production of the social and the biological, as factors that coexist, overlap, and produce each other and produce living conditions that they embody.

While physiological explanation may adopt a fragmented approach, in seeking to find "the" factor responsible for a given change/behavior,

the embodiment paradigm is a perspective in which the body exists from what is socially informed, is the residual set of socially reiterated practices (Csordas 2008).

It is worth saying that there are observable physiological differences in the study of Antarctic inhabitants (civilian scientists and military staff), whether they are evaluated during the scientific season (summer) or winter, in the ships, in the camps, or research stations. This difference is often observed not only by the degree of training and physical conditioning of the volunteers but also by the psychosocial preparation and cultural habits that the distinct professional positions require and provide to individuals.

The existence of individual conditioning raises a particular question in the context of human-related studies in Antarctica: the study of the body *in* or *in association* with the environment crosses several issues that go beyond the limits of one area of knowledge, configuring itself as an interdisciplinary theme. In this sense, the condition of humanity extends to complex cognitive functions, such as language, abstraction, imagination, and sociability, articulated in an integrated manner; wherefore, there are unpredicted research questions to arise and consider.

In addition to the approaches mentioned above through the perspectives of Csordas, the principles of obviation as proposed by Ingold (2015, 2016) can help to support, in the studies of acclimatization, the notion that the constitution and reaction of a person are not a biological or a social process, but an open entity, organized by the dynamics of evolution, adaptation, culture, and cognition. Acknowledging the socio-anthropological perspectives is an opportunity to destabilize the expected scope to sociobiological dynamics in organism dualistic (i.e., "nature" and "culture") unity. From that point onwards, knowing individuals' history and subjectivities, besides measurements of basal biological variables, can become a resource and a deepening in the understanding of physiological responses in the field. This mixed approach impacts directly the planning, collection, and interpretation of objective data obtained in the field of Antarctic human biology (Figure 2).

Quantitative methods allow the evaluation of biological factors, such as hormonal profiling, autonomic nervous system function, physical activity, muscle integrity, sleep pattern, and cognitive performance. These are usual tools used in biomedicine, depending on the adequacy of the sample size of the data based on prior studies (Figure 1). Quantitative data obtained longitudinally are submitted to descriptive statistics, stratified by categories, to characterize the population and the trajectories of variables by plotting longitudinal patterns (Figure 2).

Qualitative research is a type of research that explores and provides deeper insights into real-world problems (Moser & Korstjens 2017). Instead of collecting numerical data points, intervening, or introducing treatments just like in quantitative research, qualitative research helps generate hypotheses and further understanding quantitative data. Qualitative research gathers participants' experiences, perceptions, and behavior. It answers the hows and whys instead of how many or how much (Figure 2). It could be structured as a stand-alone study, relying on qualitative data, or as part of mixed-methods research, that combines qualitative and quantitative data. The ethnographic account elicits detailed descriptions of the experience, allowing comparisons across accounts, cultural interpretations of facts, and refinement of conceptual categories. New relevant themes may be identified from successive interviews

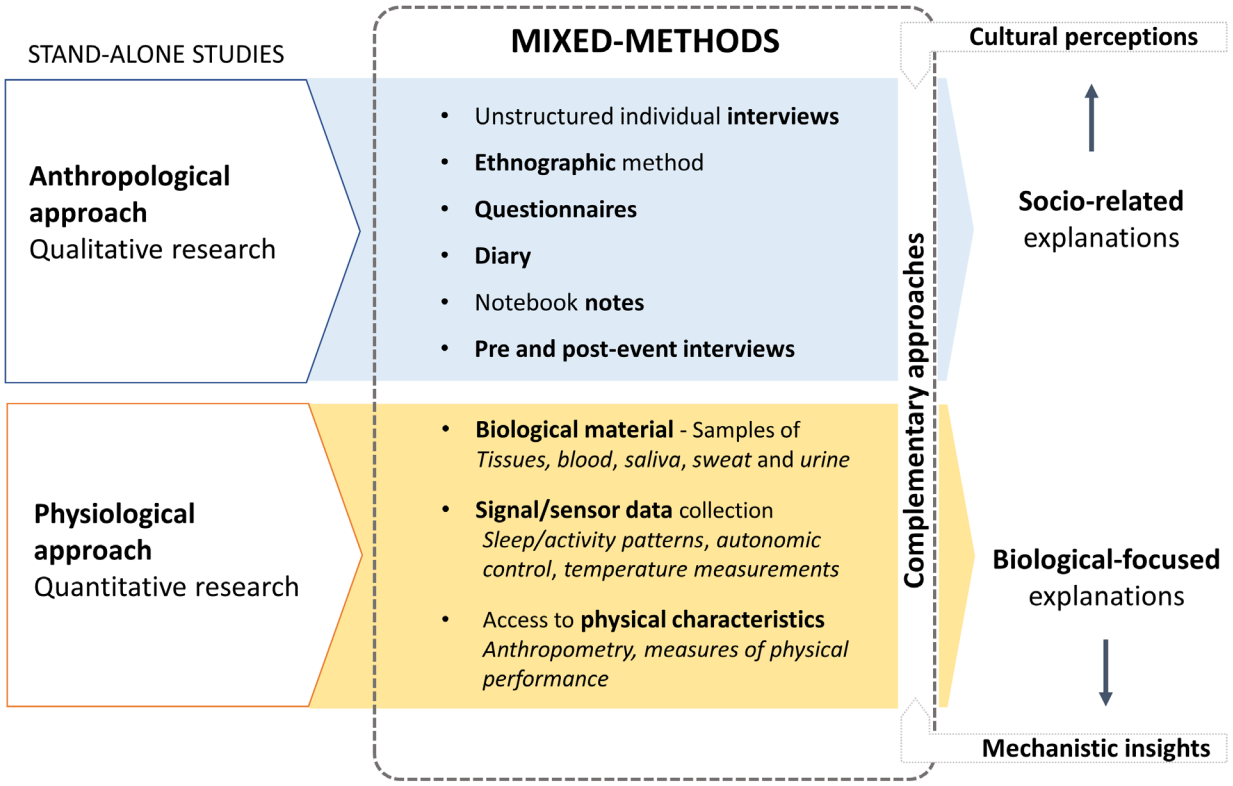

Figure 2. Perspectives on the interaction and insights for mixed-methods of human-related research activities in Antarctica. The anthropological/qualitative views and the physiology/quantitative views methods present their field research tools that result, respectively, in socio-related and biological-focused explanations. Explanations from the methods of anthropology allow for cultural insights, while explanations from the methods of physiology allow for mechanistic insights; collectively, these responses are complementary approaches that contribute to understanding the same research problem, which is the human presence in Antarctica.

and ongoing member checks will validate the developing findings (Tenny et al. 2021).

Using qualitative methods, we can examine cultural aspects of perceptions, explanations of changes, and actions taken by the Antarctica visitors, emphasizing temporal-related and social-related changes observed.

The notion of stress expresses a particularly timely concept to assess this integrated perspective: this is the case, for example, of our group observation during one Antarctic operation (Moraes et al. 2020). We evaluated the morning cortisol concentration of a group of ten individuals two days after boarding and in the fourth week of sailing on a polar vessel and observed a significant reduction in the cortisol concentration compared to the initial measurement. Cortisol is a stress-related hormone; thus, reduced cortisol may indicate lower systemic stress. However, luminosity also induces cortisol release. Since the ship's compartments present a low incidence of light, the reduction in cortisol could indicate a response to low light. The result generated questions about which specific factor prevailed in this situation, the social stress or the lighting factor, and, in this case, which of the biopsychosocial variables should be taken into account for the adequate interpretation of the results.

The field data analysis complexity also applies to the investigation of sleep patterns.

As expected, we observed sleep impairment at the beginning of the camp. However, the worsening in sleep efficiency persisted over the field; thus, we did not observe this parameter's adaptation. Therefore, the results led the researchers to assess whether dimensions non-reducible to physiological mechanisms (i.e., psychosocial aspects) could contribute to the data explanation. Thus, crossing-factors, such as cultural dimensions, psychosociological implications, and subjective interpretations about volunteers' experiences in the field, could contribute to the data understanding.

The understanding of the human dimensions at ICE implies accounting on parameters that, epistemologically, can mutually support each other for precision in obtaining and interpreting results in fieldwork. In addition, the exchange between specialties allows accessing the best paths to follow during the scientific process of analyzing and interpreting data.

It is important to create opportunities to discuss the project results enhancing opportunities for dialogue between volunteers and researchers, and between diverse research groups and the national program managers, and across lay and conduct norms, and medical discourses.

CONCLUSIONS

We expect to bring out our experience, perspectives, and motivation to facilitate the discussion on the socio-cultural dimensions of working in Antarctica while researchers in the human biology field-work. We highlighted the challenges and opportunities for researching human biology in extreme Antarctica. In the multidisciplinary sense of the term, this is ecological work, which involves understanding and articulating how social practices, including the cultural dynamics that arise at the world extremes, are established among volunteers in the Antarctic environment.

Insights on the experience of integration of science, environment, and subjectivity require rethinking theoretical assumptions on biology and culture to guide the development of new theory and empirical studies and generate actionable knowledge for practitioners working with human biology in both extreme and more traditional contexts.

Acknowledgments

The authors thank the military personnel involved in the Brazilian OPERANTAR for logistical support. Especially, the authors thank the volunteers who participated in this study. This study was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) / Ministério da Ciência, Tecnologia e Inovações (MCTIC) / Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) / Fundo Nacional de Desenvolvimento Científico e Tecnológico (FNDCT) / Programa Antártico Brasileiro (PROANTAR) [442645/2018–0]; Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) [AEC-00017–18; CDS- PPM 000304/16]; and Pró-Reitoria de Pesquisa da Universidade Federal de Minas Gerais (PRPq UFMG). RMEA received research fellowship from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) [305952/2017–0]. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Finance Code 001; MMM post-doctoral fellowship, CAPES/BRAZIL [88887.321687/2019–00].

REFERENCES

BELL ST, FISHER DM, BROWN SG & MANN KE. 2018. An approach for conducting actionable research with extreme teams. J Manage 44(7): 2740-2765.

BONET OA. 2014. Os médicos da pessoa. Um olhar antropológico sobre a medicina de família no Brasil e na Argentina. v. 1, Rio de Janeiro, 7 Letras, 266 p.

BONET OA. 2015. Sentindo o Saber. Educação da atenção e medicina da família. Horiz Antropol 2(44): 253-277.

COMNAP – COUNCIL OF MANAGERS OF NATIONAL ANTARCTIC PROGRAMS. 2021a. Christchurch, New Zealand. About Brazil's National Antarctic Program. [Online]. https://

www.comnap.aq/our-members/programa-antartico-brasileiro-proantar/. [12 Sep. 2021].

COMNAP – COUNCIL OF MANAGERS OF NATIONAL ANTARCTIC PROGRAMS. 2021b. Christchurch, New Zealand. Antarctic Information. [Online]. https://www.comnap.aq/antarctic-information/. [04 Sep. 2021].

CSORDAS T. 2008. Corpo/significado/cura. Porto Alegre, Editora UFRGS, 463 p.

DRISKELL T & DRISKELL JE. 2015. Mitigating stress effects on team cohesion. In: Salas E (Ed). Team cohesion: Advances in psychological theory, methods and practice, London, Emerald Group Publishing Limited, London, UK, p. 247-270.

FAVRET-SAADA J. 1990. "Être Affecté". Gradhiva: Revue d'Histoire et d'Archives de l'Anthropologie 8: 3-9.

GLOSSARY OF TERMS FOR THERMAL PHYSIOLOGY. 2003. Third edition. Revised by The Commission for Thermal Physiology of the International Union of Physiological Sciences (IUPS Thermal Commission). J Therm Biol 28: 75-106.

GOLDEN SJ, CHANG C & KOZLOWSKI SWJ. 2018. Teams in Isolated, Confined, and Extreme (ICE) Environments: Review and Integration. J Organ Behav 39(6): 701-715.

HARINATH K, MALHOTRA AS, PAL K, PRASAD R, KUMAR R & SAWHNEY RC. 2005. Autonomic nervous system and adrenal response to cold in man at Antarctica. Wilderness Environ Med 16(2): 81-91.

HARRISON AA, CLEARWATER YA & MCKAY CP. 1989. The human experience in Antarctica: applications to life in space. Behav Sci 34(4): 253-271.

INGOLD T. 2015. Desde la complementariedad a la obviación: sobre la disolución de los límites entre la antropología social, biológica, arqueológica y psicológica. Avá Revista de Antropología 26: 12-51.

INGOLD T. 2016. Lines: A brief history. London, Routledge classics, 208 p.

JEANTET D. 2021. "Brazil inaugurates rebuilt Antarctic research base". ABCnews. 15 January 2021. https://abcnews.go.com/Technology/wireStory/brazil-inaugurates-rebuilt-antarctic-research-base-68315204.

MAIRESSE O, MACDONALD-NETHERCOTT E, NEU D, TELLEZ HF, DESSY E, NEYT X, MEEUSEN R & PATTYN N. 2019. Preparing for Mars: human sleep and performance during a 13 month stay in Antarctica. Sleep 42(1): 10.

MARTINS YAT ET AL. 2022. A 32-day long fieldwork in Antarctica improves heat tolerance during physical exercise. An Acad Bras Cienc 94: e20210593. DOI 10.1590/0001-3765202220210593.

MORAES MM, BRUZZI RS, MARTINS YAT, MENDES TT, MALUF CB, LADEIRA RVP, NÚÑEZ-ESPINOSA C, SOARES DD, WANNER SP & ARANTES RME. 2020. Hormonal, autonomic cardiac and mood states changes during an Antarctic expedition: From ship travel to camping in Snow Island. Physiol Behav 224: 113069.

MORAES MM, MENDES TT & ARANTES RME. 2021. Smart Wearables for Cardiac Autonomic Monitoring in Isolated, Confined and Extreme Environments: A Perspective from Field Research in Antarctica. Sensors 21(4): 1303.

MORAES MM, MENDES TT, MARTINS YAT, ESPINOSA CN, MALUF CB, SOARES DD, WANNER SP & ARANTES RME. 2018. The changes in maximal oxygen uptake ($\mathring{V}O_{2MAX}$) induced by physical exertion during an Antarctic expedition depend on the initial $\mathring{V}O_{2MAX}$ of the individuals: a case study of the Brazilian expedition. Int J Circumpolar Health 77(1): 1521244.

MOSER A & KORSTJENS I. 2017. Series: Practical guidance to qualitative research. Part 1: Introduction. Eur J Gen Pract 23(1): 271-273.

NAPOLITANO DA & JONES CO. 2006. Who needs 'pukka anthropologists'? A study of the perceptions of the use of anthropology in tropical public health research. Trop Med Int Health 11(8): 1264-1275.

PALINKAS LA, REEDY KR, SHEPANEK M, SMITH M, ANGHEL M, STEEL GD, REEVES D, CASE HS, DO NV & REED HL. 2007. Environmental influences on hypothalamic-pituitary-thyroid function and behavior in Antarctica. Physiol Behav 92(5): 790-799.

PALINKAS LA & SUEDFELD P. 2008. Psychological effects of polar expeditions. Lancet 371(9607): 153-163.

PAOLETTI J, BISBEY TM, ZAJAC S, WALLER MJ & SALAS E. 2021. Looking to the Middle of the Qualitative-Quantitative Spectrum for Integrated Mixed Methods. Small Group Res 52(6): 641-675.

PATTYN N, MAIRESSE O, CORTOOS A, MARCOEN N, NEYT X & MEEUSEN R. 2017. Sleep during an Antarctic summer expedition: new light on "polar insomnia". J Appl Physiol 122(4): 788-794.

ROBERTS P, VAN DER WATT L & HOWKINS A. 2016. Antarctica: A Continent for the Humanities. In: Antarctica and the Humanities, n. 1, UK, Palgrave Macmillan, p. 1-23.

SANDAL GM, LEON GR & PALINKAS L. 2006. Human challenges in polar and space environments. Rev Environ Sci Biotechnol 5: 281-296.

TENNY S, BRANNAN GD, BRANNAN JM & SHARTS-HOPKO NC. 2021. Qualitative Study. In: StatPearls [Internet]. Treasure Island (FL), StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK470395/ [12 Dec. 2021].

VAN OMBERGEN A, ROSSITER A & NGO-ANH TJ. 2021. 'White Mars' - nearly two decades of biomedical research at the Antarctic Concordia station. Exp Physiol 106(1): 6-17.

WOLAK RJ & JOHNSON JC. 2021. Social dynamics in an isolated, confined, and extreme workplace. Int J Biometeorol 65: 437-451.

How to cite

MARQUES AL, MORAES MM & ARANTES RME. 2022. Mapping research paths and perspectives over the fieldwork of human physiology in Antarctica: reflections on the integration of science, environment, and subjectivity. An Acad Bras Cienc 94: e20210396. DOI 10.1590/0001-3765202220210396.

Manuscript received on March 15, 2021;
accepted for publication on November 10, 2021

ALICE L. MARQUES[1,2]
https://orcid.org/0000-0002-0202-3447

MICHELE M. MORAES[2,3]
https://orcid.org/0000-0003-4707-6099

ROSA M.E. ARANTES[1,3]
https://orcid.org/0000-0003-1428-9717

[1]Universidade Rural do Rio de Janeiro, Programa de Pós-Graduação em Ciências Sociais em Desenvolvimento, Agricultura e Sociedade, Av. Presidente Vargas, 417, 20071-003 Rio de Janeiro, RJ, Brazil

[2]Universidade Federal de Minas Gerais, Grupo de Pesquisa MEDIANTAR (Medicina, Fisiologia e Antropologia Antártica), Departamento de Patologia Geral, Av. Presidente Antônio Carlos, 6627, 31270-901 Belo Horizonte, MG, Brazil

[3]Universidade Federal de Minas Gerais, Núcleo de Ações e Pesquisa em Apoio Diagnóstico (NUPAD), Av. Alfredo Balena, 189, 30130-100 Belo Horizonte, MG, Brazil

Correspondence to: **Rosa Maria Esteves Arantes**
E-mail: rosa@icb.ufmg.br, rosa.esteves.arantes@gmail.com

Author contributions

Alice L. Marques, Michele M. Moraes, and Rosa M.E. Arantes contributed individually and significantly to the development of this study and approved the final version submitted for publication. ALM: designed research; collected ethnographic observations, analyzed ethnographic field observations, wrote the paper, edited the paper, and approved the submitted version. MMM: performed physiological data collections and descriptions, edited the paper, and approved the submitted version. RMEA: designed research; analyzed ethnographic field observations, wrote the paper, edited the paper, and approved the submitted version.