

 Ursula Viana Bagni<sup>1</sup>  
 Yarhima Giannina Pires  
Martins<sup>1</sup>  
 Ana Karla Silva de Lima<sup>1</sup>  
 Naiara Oliveira Medeiros<sup>1</sup>  
 Ana Paula Dias Inocência  
Barbosa<sup>1</sup>  
 Nayara Pereira Soares Silva<sup>1</sup>

<sup>1</sup> Universidade Federal do Rio Grande do Norte, Centro de Ciências da Saúde, Departamento de Nutrição. Natal, RN, Brasil.

#### Correspondence

Ursula Viana Bagni  
ursulaviana@gmail.com

Financial support: Bolsa de iniciação científica (Edital N° 01/2016 – PROPEQS UFRN)

## Temporal evolution of biochemical tests in incarcerated women

### *Evolução temporal de exames bioquímicos em mulheres privadas de liberdade*

#### Abstract

**Objective:** To investigate the evolution of biochemical parameters in incarcerated women. **Methods:** An observational prospective study involving the entire incarcerated female population in a closed regime in Natal, Rio Grande do Norte, Brazil. Biochemical tests (fasting blood glucose, total cholesterol, triglycerides, LDL-c, HDL-c, non-HDL-c) performed in the years 2012 (n = 180) and 2015 (n = 89) were compared using the Mann-Whitney, Wilcoxon and Chi-squared tests. **Results:** There was a high prevalence of low HDL-c, high Non-HDL-c and isolated hypertriglyceridemia in both years of the study. After three years of incarceration, the cohort of inmates showed an increase in fasting blood glucose concentrations (62.2mg/dL to 87.9mg/dL, p<0.001), total cholesterol (163.3mg/dL to 184.9mg/dL, p = 0.007), non-HDL-c (120.8mg/dL to 138.2mg/dL, p = 0.023), triglycerides (96.7mg/dL to 150.2mg/dL, p = 0.024) and HDL-c (42.5mg/dL to 46.7mg/dL, p = 0.012). **Conclusion:** Important biochemical changes occurred during incarceration which may favor development and worsening of chronic non-communicable diseases, highlighting the need to intensify health actions in the prison environment.

**Keywords:** Dyslipidemias. Diabetes Mellitus. Prisons. Women's health. Nutrition for Vulnerable Groups.

#### Resumo

**Objetivo:** Investigar a evolução de parâmetros bioquímicos em mulheres privadas de liberdade. **Métodos:** Estudo observacional, prospectivo, envolvendo a totalidade da população feminina encarcerada em regime fechado de Natal, Rio Grande do Norte, Brasil. Foram comparados exames bioquímicos (glicemia de jejum, colesterol total, triglicérides, LDL-c, HDL-c, não-HDL-c), realizados nos anos de 2012 (n=180) e 2015 (n=89), por meio dos testes de Mann-Whitney, Wilcoxon e Qui-quadrado. **Resultados:** Verificou-se elevada prevalência de HDL-c baixo, de Não HDL-c elevado e de hipertrigliceridemia isolada em ambos os anos do estudo. Após três anos de encarceramento, a coorte de detentas apresentou elevação nas concentrações da glicemia de jejum (62,2mg/dL para 87,9mg/dL, p<0,001), colesterol total (163,3mg/dL para 184,9mg/dL, p=0,007), não-HDL-c (120,8mg/dL para 138,2mg/dL, p=0,023), triglicérides (96,7mg/dL para 150,2mg/dL, p=0,024) e HDL-c (42,5mg/dL para 46,7mg/dL, p=0,012). **Conclusão:** Durante o encarceramento, ocorreram importantes alterações bioquímicas que podem favorecer o desenvolvimento e agravamento de doenças crônicas não transmissíveis, evidenciando a necessidade de intensificar as ações de saúde no ambiente prisional.

**Palavras-chave:** Dislipidemias. Diabetes Mellitus. Prisões. Saúde da mulher. Nutrição de grupos de risco.

## INTRODUCTION

The National Policy for Comprehensive Health Care for Persons Deprived of Liberty in the Prison System (*PNAISP*), instituted by Interministerial Ordinance No. 1/2014, provides for effective and systematic access to actions and services in the Unified Health System (*SUS*) for the entire population deprived of liberty in the prison itinerary - from pre-trial detainees at police stations and pre-trial detention facilities to convicted prisoners at state and federal prisons.

However, there are still inequalities in access to public health policies in the prison setting which potentiate health vulnerabilities in this population.<sup>1,2</sup> There is an insufficiency of educational actions for health promotion and disease prevention, high disease rates, in addition to poor medical care for detainees for treatment and rehabilitation.<sup>1-5</sup>

Although the biggest challenges for *SUS* in the prison system are communicable diseases such as HIV/AIDS, syphilis, hepatitis, tuberculosis, leprosy and scabies,<sup>3,6</sup> there is also increasing overweight and sedentarism in the prison environment,<sup>7-10</sup> as well as heart and kidney problems, strokes, hypertension and diabetes<sup>10-13</sup> due to the living conditions imposed on inmates. Thus, periodic monitoring of the health and nutrition status of persons deprived of their liberty is necessary. However, studies addressing this topic are still scarce in Brazil,<sup>2,5,10,14-21</sup> particularly those focusing on nutritional epidemiology and risk factors for chronic non-communicable diseases (NCDs) related to food and nutrition.<sup>17-20</sup>

In this sense, this study prospectively evaluated the changes in the biochemical exams of incarcerated women in a closed regime in a capital city of Northeast Brazil, with an emphasis on those related to NCDs.

## METHODS

This is an observational study composed of a cross-sectional study panel with a nested cohort of a census character, developed with the entire female prison population of Natal, in Rio Grande do Norte, Brazil.

All detainees were considered eligible and those whose medical records of the prison unit contained blood test results performed by the institution in 2012 and/or 2015 with the inmates fasting were included in the study.

Data were collected from medical records from April to May 2018 with 269 blood tests being recorded (180 performed in 2012 and 89 in 2015). The inmates were aged between 19 and 62 years in 2015, with an average of  $31.1 \pm 9.0$  years. Only 18 women participated in both assessments, since there were changes in the prison regime in the prison population in the three-year period of the study from semi-open or open, freedom or transfer between prisons. The inmates in this cohort were between 24 and 47 years old (mean of  $32.1 \pm 6.6$  years) in the follow-up year.

Results from fasting glucose (FG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c) and triglycerides (TG) were obtained from medical records. The cholesterol concentration of low density lipoproteins (LDL-c) and non-HDL-c calculations, as well as the classification of biochemical tests followed the nationally recommended guidelines.<sup>22,23</sup>

All statistical analyzes were performed using the Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago, United States) statistical software package considering a value of  $p < 0.05$  for statistical significance. The Mann-Whitney test was used for continuous variables (FG, TC, TG, LDL-c, HDL-c, non-HDL-c) and the Chi-squared test for categorical variables (prevalence of altered FG, hypercholesterolemia, hypertriglyceridemia, mixed hyperlipidemia, low HDL-c and high non-HDL-c) to compare the exam results in

the years 2012 and 2015. The Wilcoxon paired non-parametric t-test was used to compare the mean results of the exams for the inmates who underwent exams in both 2012 and 2015.

The study was approved by the Research Ethics Committee of the Hospital Universitário Onofre Lopes of the Federal University of Rio Grande do Norte (opinion no. 2,631,161; CAAE: 83154118.8.0000.5292), and followed all the precepts of the Declaration of Helsinki and Resolution no. 466/2012 of the Brazilian National Health Council.

## RESULTS

There was high prevalence of low HDL-c, high non-HDL-c and isolated hypertriglyceridemia in both years of the study, and about a third of the inmates had two or more changes in their laboratory tests (Table 1).

After three years, there was a significant reduction in the prevalence of low HDL (80.6% to 61.8%;  $p = 0.001$ ) due to the increase in HDL-c concentration (43.0mg/dL to 47.9mg/dL;  $p < 0.001$ ). The prevalence of isolated hypertriglyceridemia increased from 17.8% to 27% ( $p = 0.08$ ) (Table 1).

Although the prevalence of isolated hypercholesterolemia and altered FG did not show significant changes, there was a significant increase in the mean value of TC (166.8mg/dL to 181.2mg/dL;  $p = 0.012$ ) and fasting blood glucose (66.3 mg/dL to 81.6 mg/dL,  $p < 0.001$ ) three years after the first evaluation (still according to Table 1).

**Table 1.** Biochemical tests and prevalence of changes in incarcerated women in a closed regime (n=269). Natal, Rio Grande do Norte, Brazil, 2012/2015.

Variables	Year 2012 (N=180)		Year 2015 (N=89)		p-value
	n	%	n	%	
Low HDL-c	145	80.6	55	61.8	0.001
Elevated Non-HDL-c	40	22.2	20	22.5	0.96
Isolated hypertriglyceridemia	32	17.8	24	27.0	0.08
Isolated hypercholesterolemia	16	8.9	6	6.7	0.54
Mixed hyperlipidemia	8	4.4	1.0	1.1	0.15
Altered fasting glucose	5	2.8	2	2.2	0.80
2 or more changes in laboratory tests	52	28.9	30	33.7	0.48
	Mean	SD	Mean	SD	
HDL-c (mg/dL)	43.0	9.8	47.9	11.1	<0.001
Non-HDL-c (mg/dL)	123.7	44.0	133.3	44.7	0.11
Triglycerides (mg/dL)	111.7	78.2	130.9	88.5	0.09
Total cholesterol (mg/dL)	166.7	42.7	181.2	44.0	0.012
LDL-c (mg/dL)	102.7	39.3	110.1	41.2	0.22
Fasting glucose (mg/dL)	66.3	26.0	81.6	17.7	<0.001

In investigating the cohort of women who underwent biochemical tests at both times, it was found that there was a significant increase in HDL-c concentrations (42.5mg/dL to 46.8mg/dL;  $p = 0.012$ ), non-HDL-c (120.8mg/dL to 138.2mg/dL), TG (96.7mg/dL to 150.2mg/dL,  $p = 0.024$ ), TC (163.3mg/dL to 184.9mg/dL,  $p = 0.007$ ) and FG (62.2mg/dL to 87.9mg/dL,  $p < 0.001$ ) after three years of incarceration (Table 2).

**Table 2.** Evolution of biochemical tests in a cohort of incarcerated women in a closed regime (n=18). Natal, Rio Grande do Norte, Brazil, 2012/2015.

Variables	Year 2012 Mean (SD)	Year 2015 Mean (SD)	p-value
HDL (mg/dL)	42.5 (11.7)	46.8 (11.9)	0.012
Non-HDL-c (mg/dL)	120.8 (36.2)	138.2 (31.7)	0.023
Triglycerides (mg/dL)	96.7 (44.3)	150.2 (89.4)	0.024
Total cholesterol (mg/dL)	163.3 (33.2)	184.9 (30.9)	0.007
LDL-c (mg/dL)	101.3 (31.4)	112.5 (28.2)	0.23
Fasting glucose (mg/dL)	62.2 (6.5)	87.9 (36.6)	<0.001

## DISCUSSION

Incarcerated women in a closed regime had a high prevalence of changes in their lipid profile (low HDL-c, high non-HDL-c and isolated hypertriglyceridemia) and elevated FG after three years of incarceration. Changes in these biochemical tests can favor developing NCDs such as cardiovascular diseases (acute myocardial infarction, stroke, heart failure, peripheral vascular failure), as well as cancers which are responsible for the largest number of deaths in the world.<sup>22-24</sup>

The prevalences presented herein are similar to those observed in other international studies with PDL.<sup>12,13</sup> NCDs are responsible for more than 70% of deaths in the population in Brazil,<sup>22</sup> with high and rising prevalence of diabetes, dyslipidemia and arterial hypertension.<sup>25-27</sup> Specifically in PDL, studies carried out in the Southeast and Northeast of the country have already reported the presence of hypertension and diabetes,<sup>2,10,17</sup> as well as dyslipidemia,<sup>17</sup> overweight<sup>10,17</sup> and a sedentarism.<sup>10,17</sup>

Although the majority of inmates in the present study were not diagnosed with diabetes, there was a significant increase in the average FG after three years of incarceration (41.3% increase), showing an increase in their health risk. The prevalence of diabetes in a penitentiary complex in the Federal District was also low (0.54%), but the authors warned of the difficulty in maintaining glycemic levels within normal limits in this environment due to the conditions and practices experienced by inmates such as the use of licit and illicit drugs, restricted healthcare and sedentarism associated with inadequate nutrition.<sup>21</sup>

The diets in prison are not very varied, with a low frequency of fruit and vegetable consumption associated with high consumption of processed and ultra-processed foods rich in sodium and sugar.<sup>16,18,28</sup> This food profile is in line with what has been observed in the Brazilian population in general<sup>26,29</sup> and in association with the predominant sedentary lifestyle in the prison environment<sup>2,10,12,13</sup> may favor an increase in body adiposity and the development of dyslipidemia, arterial hypertension and diabetes.<sup>17,23,24</sup>

It is important to highlight that although there was a significant increase in HDL-c values after three years of incarceration, there was also a significant increase in non-HDL-c concentration. This biochemical parameter has the purpose of estimating the amount of atherogenic lipoproteins circulating in the plasma and the risk of cardiovascular diseases, especially in individuals with high TG,<sup>22</sup> as is the case in the investigated women. Thus, it is not possible to state that the increase in HDL-c would be sufficient to prevent the development of NCDs in this cohort of inmates.

Limitations inherent to the present study deserve to be pointed out, such as: an absence of interviews by the health team with the inmates when examining the prison unit; inaccurate information about the total incarceration time, since many had already been detained at other times in life or had followed other imprisonment regimes since their last imprisonment, resulting in inaccurate reporting. Thus, it was not feasible to investigate the factors associated with changes in biochemical tests. Furthermore, the cohort of women with examinations at both times was small, as most of the participants left the prison unit; also changes in the prison itinerary from the closed to semi-open or open prison system, freedom or transfer between prisons are common.

Despite the challenges and limitations inherent to investigations with PDL, the results presented herein reflect the reality of the female prison population in a closed regime in the capital of the state of Rio Grande do Norte. They also reveal the temporal evolution of biochemical tests in a cohort of inmates in an unprecedented way at the national level, demonstrating the fragility of healthcare in the prison system: high prevalence, with two or more changes in biochemical tests, and worsening of the lipid profile and blood glucose levels over the years of incarceration.

## CONCLUSION

It is concluded that biochemical changes which occur during incarceration may favor the development of NCDs. Thus, the importance of comprehensive health actions with multidisciplinary and transdisciplinary character and longitudinality in care in prison is reinforced, aiming at reducing alarming health inequities in the prison system. It also points to the need for more assertive action by health teams and prison managers, and for the improvement in public policies aimed at this marginalized population in order to minimize the effects of prison on their health conditions and consequently on their re-socialization into freedom

## REFERENCES

1. Soares-Filho MM, Bueno PMMG. Demografia, vulnerabilidades e direito à saúde da população prisional brasileira. *Ciência & Saúde Coletiva* 2016; 21(7):1999-2010.
2. Santos MV, Alves VH, Pereira AV, Rodrigues DP, Marchiori GRS, Guerra JVV. A saúde física de mulheres privadas de liberdade em uma penitenciária do estado do Rio de Janeiro. *Escola Anna Nery* 2017; 21(7): e20170033.
3. Brasil. Ministério da Justiça. Levantamento Nacional de Informações Penitenciárias - INFOPEN 2014. Brasília: Ministério da Justiça; 2015.
4. Kölling GJ, Silva MBB, Sá MCDNP. O Direito à Saúde no Sistema Prisional. *Rev Tempus Actas Saúde Col* 2013;7(1):281-297.
5. Pinheiro MC, Araújo JL, Vasconcelos RB, Nascimento EGC. Health profile of freedom-deprived men in the prison system. *Invest Educ Enferm*. 2015; 33(2): 269-279.
6. Moraes ALZ. Tuberculose e Cárcere. In: Rigon BS, Silveira FL; Marques J (Org.). *Cárcere em Imagem e Texto*. 1 ed. Porto Alegre: Livraria do Advogado, 2015.
7. Haysom L, Indig D, E Moore, Hardy LL, van denDolder PA. Prevalence and perceptions of overweight and obesity in Aboriginal and non-Aboriginal young people in custody. *Med J Aust*. 2013; 199(4):266-70.
8. LeddyMA, Schulkin J, Poder ML. Consequences of high incarceration rate and high obesity prevalence on the prison system. *J Correct Health Care*. 2009; 15(4):318-27.
9. Clarke JG, WaringME. Overweight, obesity, and weight change among incarcerated women. *J Correct Health Care*. 2012; 18(4):285-92.
10. Audi CAF, Santiago SM, Andrade MGG, Francisco PMSB. Inquérito sobre condições de saúde de mulheres encarceradas. *Saúde Debate* 2016; 40(109):112-124.

11. Nowotny KM, Rogers RG, Boardman JD. Racial disparities in health conditions among prisoners compared with the general population. *SSM Popul Health* 2017; 3:487-496.
12. Vera-Remartínez EJ, Borraz-Fernández JR, Domínguez-Zamorano JA, Mora-Parra LM, Casado-Hoces SV, González-Gómez JA et al. Prevalence of chronic diseases and risk factors among the Spanish prison population. *Revista Española de Sanidad Penitenciaria* 2014; 16(1):38-47.
13. Voller F, Silvestri C, Martino G, Fanti E, Bazzler G, Fabio Ferrari et al. Health conditions of inmates in Italy. *Bmc Public Health* 2016; 16(1):1-10.
14. Mello DC. A prisão feminina: gravidez e maternidade: um estudo da realidade em Porto Alegre – RS/Brasil e Lisboa/Portugal [Tese de doutorado]. Porto Alegre (RS): Universidade Católica do Rio Grande do Sul; 2014.
15. Martins VC. Avaliação da alimentação fornecida pelo DEPEN, na casa de custódia de Curitiba, no centro de detenção e ressocialização de Piraquara e na penitenciária central do Estado [Monografia de especialização]. Curitiba (PR): Universidade Federal do Paraná; 2007.
16. Oliveira LMB. Práticas alimentares e condições de alimentação de mulheres presidiárias em regime fechado [Monografia]. Natal (RN): Universidade Federal do Rio Grande do Norte; 2017.
17. Amorim FMC. Estado nutricional e consumo alimentar da população carcerária feminina de Natal, RN [Monografia]. Natal (RN): Universidade Federal do Rio Grande do Norte; 2014.
18. Silva JC. Avaliação do consumo alimentar de mulheres encarceradas à luz do Guia Alimentar para População Brasileira [Monografia]. Natal (RN): Universidade Federal do Rio Grande do Norte; 2017.
19. Andrade ALCC, Barbosa APDI, Bagni UV. Imagem corporal no cárcere: percepções de mulheres privadas de liberdade. *Demetra*; 2018; 13(2):381-393
20. Barbosa APDI. Imagem corporal em mulheres privadas de liberdade [Dissertação de mestrado] Natal (RN): Universidade Federal do Rio Grande do Norte; 2018.
21. Ferreira MCO. Desafios no manejo do diabetes mellitus em pacientes de uma penitenciária do distrito federal [Dissertação de mestrado] Brasília (DF): Universidade de Brasília; 2014.
22. Faludi AA, Izar MCO, Saraiva JFK, Chacra APM, Bianco HT, Afiune Neto A et al. Atualização da Diretriz Brasileira de Dislipidemias e Prevenção da Aterosclerose – 2017. *Arq Bras Cardiol* 2017; 109(2Supl.1):1-76.
23. Oliveira JEP; Vencio S (Org). Diretrizes da Sociedade Brasileira de Diabetes (2015-2016). São Paulo: A.C. Farmacêutica, 2016.
24. World Health Organization. Global Status Report on Noncommunicable Diseases 2014 [Internet]. Geneva: World Health Organization; 2014 [2012 abr 18]. Disponível em: <https://www.who.int/nmh/publications/ncd-status-report-2014/en/>.
25. Malta DC, Stopa SR, Szwarwald CL, Gomes NL, Silva Júnior JB, Reis AAC. A vigilância e o monitoramento das principais doenças crônicas não transmissíveis no Brasil – Pesquisa Nacional de Saúde, 2013. *Rev. Bras. Epidemiol* 2015; 18(supl.2):3-16.
26. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde 2013: percepção do estado de saúde, estilos de vida e doenças crônicas. Rio de Janeiro, Instituto Brasileiro de Geografia e Estatística; 2014.
27. Brasil. Ministério da Saúde. Vigitel Brasil 2016: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados brasileiros e no Distrito Federal em 2016. Brasília: Ministério da Saúde; 2017.
28. Paiva TRL. Mulheres presidiárias: as grades que cercam [Monografia]. Campina Grande (PB): Universidade Federal de Campina Grande; 2017.
29. Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009: Análise do consumo alimentar pessoal no Brasil. Rio de Janeiro, Instituto Brasileiro de Geografia e Estatística; 2011.

**Contributors**

Bagni UV aided in all study stages, including design and planning, data collection coordination, and statistical analysis of the data. Field data collection was performed by Silva NPS, Bagni UV and Lima AKS. All authors acted in the literature review, interpretation of results, writing and revision of the final version of the manuscript

---

Received: July 30, 2019

Accepted: October 19, 2019