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# Favorable research environment is a key determinant of research integrity according to a ten-country survey across Central and Eastern Europe

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1 **Favorable Research Environment is a Key Determinant of Research Integrity According**

2 **to a Ten-Country Survey Across Central and Eastern Europe**

3

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17

18 **Abstract**

19

20 Our study was designed to investigate research integrity among scientists actively working in

21 biomedicine. Using the unique opportunity of the Alliance for Life Sciences, a networking

22 initiative of leading research institutions and universities in Central and Eastern Europe, we

23 organized our own in-depth survey on research integrity in the countries involved. We

24 employed a standardized questionnaire consisting of 19 closed questions with simple, multiple-

25 choice, or scaled responses to explore the situation regarding research integrity at Alliance for

26   Life Sciences member institutions. The questionnaire was in English language and was

27   administered through the Qualtrics platform anonymously. Finally, 10 institutions from 10

28   different countries participated in the study and the aggregated group of respondents consisted

29   of 752 scientists. First, the analysis of the obtained data included descriptive frequencies of the

30   responses to all types of questions. Second, the construction and analysis of the model of latent

31   variables was included to verify assumptions about individual aspects of the observed behavior

32   and their interrelationships. Confirmatory factor analysis was applied to verify the domain

33   structure, followed by multivariate analysis of variance to assess the effects of institutional

34   affiliation, gender, seniority, and ethics training. Our data provide the first systematic

35   description of research integrity at the biomedical research institutions in 10 Central and Eastern

36   European countries. Because the majority of our respondents were experienced researchers, our

37   study is really valuable for mapping the state of research integrity in participating countries.

38   The descriptive part of the results brings a detailed insight into the research environment in

39   relation to research integrity, as well as recent and former personal experiences with scientific

40   misconduct. It also covers the personal acceptability of various forms and consequences of

41   scientific misconduct and personal estimations of scientific misconduct. The unique findings of

42   our study came from the model showing the correlations between latent and higher-order

43   variables, which reflect relevant domains of the questionnaire. Moreover, seniority and ethics

44   training were identified as predictors of adherence to the principles of research integrity. These

45   results emphasized the importance of the favorable research environment regarding scientific

46   integrity, which is apparently interconnected with the incidence of various forms of misconduct

47   as experienced recently or in the past. Our study using a model of latent variables yielded unique

48   results that clearly showed the importance of fostering a favorable research environment,

49   especially through systematic education in research integrity and available institutional policies

50   that both reduce the risk of scientific misconduct.

51

**Keywords**

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research integrity; biomedical research; scientific misconduct; scientific fraud; fabrication; falsification; plagiarism; questionable research practices; research environment

56

**Background**

58

Scientific integrity is widely understood and accepted as an essential cornerstone of research activities, underpinning the trustworthiness and reliability of results and outcomes. In the last few decades of rapid scientific progress and increasing global competition, accompanied by more or less medialized examples of scientific fraud, the phenomenon of scientific misconduct and questionable research practices has begun to be studied systematically [1, 2, 3] or with a focus on its special aspects, such as data curation [4, 5, 6], statistical analyses [7, 8, 9] or authorship issues [10]. As a consequence, research institutions have come under scrutiny for their adherence to standards of research ethics and research integrity [11, 12].

Over the past years, several surveys have been published that examine the current state of scientific integrity in a variety of academic and research organizations, with the goal of highlighting both the strengths and challenges of existing institutional frameworks, particularly at the national levels. Such studies have been conducted, for example, in Japan [13], China [14], Norway [15], Hungary [16] and in the Netherlands [17]. In addition, some interesting data from international surveys [18] and meta-analyses are also available [19, 20, 21], although the difficulties arising from methodological heterogeneity did not allow a clear and unbiased interpretation of the data analyzed [22].

75    Furthermore, several studies with a particular focus on Ph.D. students and/or early career

76    researchers have been carried out in the last decade as well. These studies included participants

77    from one research institution, e.g. the School of Medicine of the University of Zagreb, Croatia

78    [23] or the Department of Clinical Research and Department of Regional Health Research,

79    University of Southern Denmark [24], selected or all relevant institutions in one country [25],

80    or selected institutions in one geographic region, namely Scandinavia [26, 27]. All of them

81    explored how individuals navigate complex issues such as data management, authorship

82    disputes, conflicts of interest, and the various pressures that can compromise their research

83    integrity. The findings consistently revealed the urgent need for robust oversight mechanisms,

84    transparent reporting procedures, and comprehensive ethics training programs to cultivate an

85    environment of accountability and openness within the scientific community. In the context of

86    research integrity studies, these factors are referred to as key contributors to a healthy,

87    supportive or favorable research environment [23, 27, 28, 29].

88    Nevertheless, there are only a few results mapping the situation in the international context. We

89    have therefore seized the unique opportunity offered by the Alliance for Life Sciences, a

90    networking initiative of twelve leading life science institutions and universities from eleven

91    Central and Eastern European countries that aims to bridge the gap in European health research

92    and innovation. With the aim to investigate the situation of research integrity in the member

93    institutions of the Alliance for Life Sciences using a standardized methodology, we adapted the

94    already developed questionnaire to organize our own in-depth survey on research integrity.

95

96    **Methods**

97

98    **Target group**

4

99    The purpose of this study was to explore the extent to which academic and research integrity is

100   important to scientists actively engaged in biomedical research. Our survey was conducted

101   under the framework of the international Alliance for Life Sciences (A4L) project covering 12

102   research institutions in 11 countries of Central and Eastern Europe: Bulgaria, Croatia, Czechia,

103   Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia (Table 1).

104   In accordance with this aim, we decided to approach the target group of scientists actively

105   involved in biomedical research at the partner institutions. The term "scientists" was defined as

106   employees involved in biomedical research in the role of researchers. In other words, Ph.D.

107   students without an employment contract were not invited to participate. Similarly, technicians,

108   research nurses and other categories of supporting staff were not addressed. The target group at

109   each institution/institutional unit (Table 1) was defined with the help of the institutional HR

110   departments.

111

## Questionnaire

113   We used a complex questionnaire designed to identify scientific misconduct and questionable

114   research practices [23], originally based on questionnaires used in similar studies in

115   Scandinavian countries [25, 27, 28, 30]. However, as our target group differs from the previous

116   one for which the questionnaire was originally developed, i.e., medical students, Ph.D. students,

117   and their supervisors [23], we modified the questionnaire by adding the introductory and final

118   blocks of questions. The full version of this improved questionnaire (hereafter referred to as the

119   A4L Questionnaire) is provided (Additional File 2). This A4L Questionnaire was administered

120   in English only.

121   Our A4L Questionnaire consisted of nineteen questions (Q1-Q19), starting with nine

122   "demographic" questions related to the participant's academic career (Q1-Q7) followed by

123   examining the previous education in "science ethics" (Q8-Q9). We used this generic term

124 "science ethics" instead of "research integrity" because some scientists may not be familiar with

125 the difference between "ethics" and "integrity. In addition, we avoid the field-specific term

126 "bioethics" or "medical ethics" because we also approached scientists from other disciplines

127 who also worked in the biomedical sciences.

128 Next part of the A4L Questionnaire included multiple-choice questions focusing on personal

129 experiences with scientific misconduct. These five questions mapped participants' experiences

130 with different types of scientific misconduct in the past 12 months (Q10-Q14).

131 Following part examined participants' personal experiences and attitudes toward the

132 problematic behavior in detail, also through detailed scaled-response questions. The first of

133 them (Q15) addressed the frequency of personal participation in various types of scientific

134 misconduct in the past 3 years. The next question (Q16) measured the personal acceptability of

135 some defined types of scientific misconduct, as well as the willingness to report such scientific

136 misconduct of others and to share the blame and punishment in case of personal involvement.

137 The last question (Q17) of this section measured personal opinions on the frequency of

138 scientific misconduct, the risk of its detection, and the consequences of such detection for the

139 scientists involved.

140 The penultimate multiple-choice question (Q18) was focused on mapping written policies

141 regarding different types of scientific misconduct. The closing question (Q19) was aimed at the

142 identification of the scientific role of the participant. We adopted the categories of the

143 Contributor Role Taxonomy (CRediT) [31] used for the classification of contributor roles in

144 scientific publications, and it was also administered as a multiple-choice question.

145

146 **Questionnaire distribution**

147 As a first step, the members of the research team approached the persons responsible (scientific

148 directors, vice-deans for research, etc.) at their home institutions with an invitation to participate

149 in this survey. The invitation was always sent by e-mail in a national language, and the

150 invitation letter was attached in English (Additional File 1). If the person in charge agreed with

151 the participation of his/her home institution or institutional unit (faculty, research center, etc.)

152 in this survey, the link to the online questionnaire was provided for distribution to the scientists

153 of the institution/unit in question. This email was always bilingual, in the national language

154 followed by English. In institutions with more than one institutional unit, each unit sent its own

155 invitation to participate in the survey. Participants with contracts with more than one of these

156 units were asked to respond only once, using the link provided by their main workplace/unit.

157 Because differences in distribution procedure and willingness to participate in this survey were

158 to be expected not only between A4L project partner institutions, but also between units within

159 an institution, we decided to collect responses from each institutional unit separately, in

160 individual datasets. The co-authors of this article served as institutional coordinators for this

161 survey.

162 The A4L Questionnaire was administered on the Qualtrics platform and responses were

163 collected in a strictly anonymous setting. Personal data and IP addresses were not collected. As

164 the questionnaire was designed to be completed on a computer, participants were asked not to

165 use smartphones. Participants were also informed of the estimated completion time, which was

166 approximately 10 minutes.

167 For basic definitions of terms used in the questionnaire, participants were provided with the

168 link to the Glossary on the website of the European Network for Academic Integrity (ENAI)

169 [32] and were encouraged to use it in case of uncertainty.

170 The survey was conducted between October 2022 and April 2023. For each institutional unit,

171 the link to the questionnaire was always active for 120 days. The detailed overview of the timing

172 is shown in Table 1. The differences in timing reflected the specific circumstances of each

173 participating institution/institutional unit.

174

175 **Descriptive data analysis**

176 As the questionnaire structure was identical for all the datasets, we evaluated the data as

177 aggregated. This aggregated group of respondents consisted of 752 scientists. The analysis of

178 the obtained data included descriptive frequencies of the responses to all types of questions

179 (simple, multiple-choice, and scaled-response).

180

181 **Confirmatory factor analysis**

182 We employed confirmatory factor analysis (CFA) to test the hypothesis that the questionnaire

183 domains [23] represent distinct latent variables. This approach allowed us to validate the

184 structure of the domains and estimate their relationships through correlations among the latent

185 factors.

186 We chose to parcel items in order to improve model parsimony by reducing the complexity of

187 the full model [33]. Details regarding the assignment of individual items to parcels are presented

188 in Table 4; parcels were computed as the sum of their respective items. Parcel factor loadings

189 are presented in Table 5. To justify the use of item parcels, we first ensured that the underlying

190 assumptions were satisfied. Specifically, we examined the internal consistency (Cronbach's α

191 ranging from 0.65 to 0.85, M = 0.74) and confirmed the unidimensionality of the domains via

192 separate CFAs.

193 Given the high intercorrelations and very similar factual meaning within specific subsets of

194 latent variables, we estimated two higher-order variables: "Threat" (THR, indicated by

195 Common Occurrence" (CO), "High Risk of Detection" (HRD), "Severe Consequences" (SC))

196 and "Last-Year Misconduct" (LYM, indicated by "Recent FFP Pressure" (RFP), "Recent

197 Misconduct" (RM), "Recent Awareness" (RA), "Recent QRP Pressure" (RQP), and "Recent

198 Consequences" (RC)). No cross-loadings and correlations between residuals were allowed.

199  The model, analyzed using robust maximum likelihood (RML) with NLMINB optimization,

200  demonstrates satisfactory fit to the data based on several key indices. With 150 parameters and

201  752 observations (67 missing patterns), the model yielded a chi-square value of 1912.466

202  (scaled: 1590.742) with 629 degrees of freedom. The Comparative Fit Index (CFI=0.923, robust

203  CFI=0.932) and Tucker-Lewis Index (TLI=0.914, robust TLI=0.924) approach the

204  recommended threshold of 0.95, indicating good fit. The Root Mean Square Error of

205  Approximation (RMSEA=0.052, robust RMSEA=0.049) with its 90 % confidence interval

206  (0.049-0.055; robust: 0.046-0.053) and the Standardized Root Mean Square Residual

207  (SRMR=0.057) both fall below their respective cutoff values of 0.06 and 0.08, further

208  supporting the model's adequacy. All data related to the construction and analysis of this model

209  are provided (Additional File 3). For subsequent analyses, we estimated the values of all the

210  latent variables as regression scores.

211

212  **General linear model (MANOVA)**

213  Latent variable scores were analyzed using a General Linear Model (multivariate ANOVA) in

214  SPSS 31.0  to examine the hypothesized effects of respondent characteristics (institutional

215  background, gender, seniority, doctoral supervision, and ethics training) on the questionnaire's

216  core domains. We chose this strategy to reduce the complexity of the data into a manageable

217  and interpretable exploratory framework.

218  We assessed the assumption of homogeneity of variance using Levene's test. When all

219  predictors were included, the assumption was violated for half of the dependent variables:

220  Unacceptable Misconduct (F=1.57, p<0.001), Former Misconduct (F=1.58, p<0.001),

221  Reporting Obligation (F=1.44, p<0.001), and Last Year Misconduct (F=1.51, p<0.001).

222  However, it is evident that this violation is driven by a single predictor – institutional affiliation

223  – which reflects the unavoidable imbalance in the sample structure. When this predictor is

224　excluded, the assumption of homogeneity of variance is met for all dependent variables. Given

225　the substantial sample size (N=752) and the robustness of the MANOVA, we argue that

226　retaining 'Institution' in the model is justified, as it provides a more accurate representation of

227　the collected data.

228　Furthermore, visual inspection of Q-Q plots confirmed that the distribution of residuals is

229　approximately normal.

230

231　**Ethical considerations**

232　The intent to conduct this survey was presented to the institutional research ethics committees

233　(RECs). Each REC was provided with the full version of the A4L questionnaire along with a

234　cover letter. Nevertheless, this type of research is subject to different types of ethical evaluation

235　according to specific national legislation. For this reason, our survey was either subjected to

236　ethical review and approved to be conducted (Croatia, Hungary, Slovenia) or a statement was

237　issued that ethical review was not required (Bulgaria, Czechia, Latvia, Lithuania, Poland,

238　Romania, Slovakia).

239　The survey itself was administered online only and was completely anonymous. Under these

240　conditions, no written consent was obtained from the respondents. Nevertheless, respondents

241　were informed about the format, length and anonymity measures of the questionnaire on the

242　introductory screen of the survey. By clicking the 'Start the survey' button, respondents provided

243　their implicit informed consent to participate. Such a procedure is fully compliant with ethical

244　standards for anonymous online surveys and fully meets the requirements of confidentiality and

245　voluntary participation.

246

247　**Results**

248

**Participation in the study**

As shown in Table 1, 10 institutions from 10 different countries finally participated in this study

and 21 individual data sets were collected in total.

The evaluation of response rate consists of two parameters – reaction rate and completion rate

(Table 2). The reaction rate was defined as the number of participants who opened the online

A4L Questionnaire using the link provided in the invitation e-mail. This parameter varied from

71.54 % (Semmelweis University, Faculty of Medicine) to 5.33 % (Medical University of Lodz,

Faculty of Medicine and Dentistry). Completion rate was defined as the number of respondents

who fulfilled the entire questionnaire and it varied from 34.15 % (Semmelweis University,

Faculty of Medicine) to 2.32 % (Medical University Sofia, Faculty of Dental Medicine),

although in three other cases the completion rate was also similarly very low: 2.36 %

(Semmelweis University, Faculty of Dentistry), 2.56 % (Medical University of Lodz, Faculty

of Medicine and Dentistry), and 3.50 (Medical University Sofia, Faculty of Pharmacy).

Interestingly, the response rate, i.e., the ratio of the completion rate to the reaction rate, which

indicates the willingness of those who have already opened the survey to complete it, varied

between 0.40 and 0.60 in most of the participating institutions or institutional units, regardless

of the percentage of respondents participating (Table 2).


**Demographic and professional characteristics of the respondents**

This overview describing the respondents' backgrounds in detail is provided in Fig. 1. The

obtained data on gender (Fig. 1a) showed that 56.6 % of respondents identified as female, 42.2

% identified as male, and 0.9 % chose not to disclose their gender (Q5).  Regarding professional

background (Fig. 1b), 53.3 % of respondents had a healthcare background, 44.9 % did not, and

1.9 % chose not to answer this question (Q6). The specialization of their doctoral studies (Fig.

1c) was in basic research in the life sciences for 63.2 % of respondents, in clinical research for

274 29.0 %, and in other disciplines for 11.8 % (Q7). Regarding professional history (Fig. 1d), 91

275 % of respondents completed their undergraduate studies in the same country where they were

276 working at the time of the survey (Q1) and there was only a very small change for doctoral

277 studies, with 89 % of respondents reporting that they also completed their doctoral studies in

278 the same country (Q2).

279 In terms of career length (Fig. 1e), 23.7 % of respondents had worked as researchers for up to

280 5 years, 16.2 % had worked as researchers for 6-10 years, 14.8 % had worked as researchers

281 for 11-15 years, and 44.5 % had worked as researchers for more than 15 years (Q3). For more

282 detailed understanding of the scientific role and experience of participants, the multiple-choice

283 question adopting the categories of CRediT [34] was included (Q15); the responses to this

284 question are summarized in Table 3. In addition to the respective category in CRediT, the

285 supervision experience was mapped in more detail (Fig. 1f) : 51.3 % of respondents reported

286 none, and 31.9 % of respondents had supervised up to 5 students. 10.1 % of respondents had

287 supervised 6-10 students, 3.3 % had supervised 11-15 students, and 2.4 % had supervised more

288 than 15 students during their career. 0.9 % of respondents did not report the number of students

289 they supervised (Q4).

290

291 **Research environment**

292 The research environment in the context of research integrity (Fig. 2) was evaluated in terms of

293 previous education of the respondents – although this could be obtained anywhere –, and the

294 existence of written institutional policies on specified sensitive issues.

295 The situation regarding previous education (Fig. 2a) in science ethics was mapped for both

296 undergraduate (Q8) and doctoral (Q9) studies; the term "education" encompassed both

297 individual lectures and specialized courses. 36.3 % of respondents reported this type of

298 education during their undergraduate studies and 32.8 % of respondents during their doctoral

299   studies. Interestingly, 8.5 % of respondents did not remember whether or not they had

300   completed any kind of science ethics education for their undergraduate studies, and 9.2 % did

301   not remember this for their doctoral studies. No education in science ethics confirmed 55.2 %

302   for undergraduate studies, and 58.1 % for doctoral studies.

303   The existence of written institutional policies (Fig. 2b) varied according to the specific issue

304   covered by the respective policy. Not surprisingly, the most common topic of written policy

305   was plagiarism, with 45.3 % of respondents reporting this policy at their home institutions,

306   followed by rules for the use of funds (42.2 %). In contrast, the least frequent written policies

307   were reported for changes in design/methods (16.5 %) and changes in results (18.4 %).

308   However, it is also noteworthy that the proportion of respondents who were unsure whether

309   such a policy existed at their home institution was relatively high and stable, ranging from 32.0

310   % to 47.8 %.

311

312   **Recent personal experiences with scientific misconduct**

313   The next set of multi-choice questions was intended to identify personal experiences with

314   defined categories of scientific misconduct in the past 12 months. The results are summarized

315   in Fig. 3.

316   First, respondents were asked about their personal confrontation with scientific misconduct of

317   varying degrees of severity – fabrication, falsification or plagiarism of data, misleading

318   presentation of data, and plagiarism of publications. In order to distinguish the level of personal

319   encounter, the questions were directed at passive exposure / enforcement without action (Fig.

320   3a, Q10) or active engagement (Fig. 3b, Q11). The next question was focused on awareness of

321   scientific misconduct in the respondent's own department; however, for this question, the data

322   plagiarism and misleading presentation of data were combined into a category of misleading

323   presentation of results (Fig. 3c, Q12). Not surprisingly, the levels of confession rate for both

324 passive exposure / enforcement and active engagement were extremely low. For passive

325 exposure / enforcement (Fig. 3a), confirmed experience ranged from 0.5 to 4.3 % and

326 uncertainty about the situation from 0.9 to 3.9 %. Active engagement in scientific misconduct

327 (Fig. 3b) was confirmed by up to 1.1 % of respondents, with an additional up to 3.3 % reporting

328 uncertainty about the situation. In contrast, the awareness of scientific misconduct by colleagues

329 (Fig. 3c) increased up to 8.9 %, with an additional 14 % of respondents unsure about the

330 situation. For all three questions, experience with scientific misconduct was most frequently

331 reported in the category of misleading presentation of data / results.

332 Following two questions also mapped the respondent's experience within the period of the past

333 12 months with the use of different categorizations of scientific misconduct. First of them was

334 aimed at personal exposure to "unethical pressure" again, but with the use of broader categories

335 covering the subject of such a pressure (Q13). As these categories did not match the ones used

336 in Q10, the frequency of reported experience was almost double ranging from 2.5 % regarding

337 design or methods to 22.2 % regarding authorship issues accompanied by uncertainty between

338 2.8 and 7.1 % for the respective categories (Fig. 3d). The last question in this part of the survey

339 focused on the personal experience with the consequences of scientific misconduct (Q14). The

340 reported experience ranged from 2.7 % of respondents affected by legal consequences to 6.4 %

341 of those affected by ethical consequences (Fig. 3e).

342

343 **Three-year personal experiences with scientific misconduct**

344 The next scaled-response question was aimed at the frequency of personal participation in

345 specified types of scientific misconduct in the past 3 years (Q15). The options included both

346 the severe forms of scientific misconduct, i.e. fabrication, falsification and plagiarism (FFP), as

347 well as other questionable research practices (QRP), which are considered mild to moderate

348 forms of scientific misconduct. The results are summarized in Fig. 4.

349   The results showed that the most frequently reported form of scientific misconduct was gifted

350   authorship (45.4 % of experienced respondents in total), followed by N-hacking (34.7 % of

351   experienced respondents in total) and retention of results (28.0 % of experienced respondents

352   in total). On the other hand, the least common misconduct was hidden funding in publication

353   and for undisclosed conflict of interests (1.5 % of experienced respondents in total in both

354   cases), followed by accepting undue influence from funder (2.7 % of experienced respondents

355   in total) and breach of reviewer confidentiality (3.0 % of experienced respondents in total).

356

357   **Personal acceptability of various forms and consequences of scientific misconduct**

358   The next scaled-response question was focused on the personal acceptability of some defined

359   forms of scientific misconduct, both FFP and QRP, as well as the willingness to act as a

360   whistleblower in case of others or to share the blame and punishment in case of personal

361   involvement (Q16). The results are summarized in Fig. 5.

362   The results on personal acceptability of specified forms of scientific misconduct (Fig. 5a)

363   showed that manipulating data in a project proposal was the most acceptable practice (42.9 %

364   of respondents), followed by removing outliers in the case of confidence in findings (26.4 % of

365   respondents). In contrast, the least acceptability was reported for data falsification (5.2 % of

366   respondents), tightly followed by stealing of ideas (5.3 % of respondents), plagiarism (5.4 % of

367   respondents) and stealing of data (5.8 % of respondents).

368   The willingness to act in the case of someone's misconduct (Fig. 5b) was reported as more or

369   less acceptable by 75.0 % of respondents; however, the willingness to act as a whistleblower

370   decreased to 61.6 % in the case of a colleague and to 59.2 % in the case of a supervisor or

371   principal investigator. In terms of consequences in case of severe misconduct, e.g. data

372   fabrication (Fig. 5b), the sharing of the blame was more or less acceptable for 47.4 % of

373    respondents. However, the sharing of punishment in the same situation was more or less

374    acceptable for 38.3 % of respondents.

375

376    **Personal estimation of misconduct**

377    This scaled-response question was focused on the personal estimation of misconduct in one's

378    own field of research in terms of common occurrence, risk of detection, and severe

379    consequences of detection (Q17). For each of these aspects, three forms of misconduct were

380    assessed: severe or mild scientific misconduct (without further specification) and authorship

381    misconduct. The results are summarized in Fig. 6.

382    Respondents estimated authorship misconduct to be the most frequent, followed by mild and

383    severe misconduct (Fig. 6a). Nevertheless, the estimation of the high risk of being detected

384    showed an inverse pattern: the respondents expected the highest probability of detection for

385    severe scientific misconduct, followed by mild and authorship misconduct (Fig. 6b). Finally,

386    the consequences of being detected were also estimated to be severe also for severe scientific

387    misconduct, followed by mild misconduct and authorship misconduct (Fig. 6c).

388

389    **Confirmatory factor analysis**

390    All significant relationships ($p < 0.05$) among latent variables are summarized as a correlation

391    matrix (Table 6) and plot visualization (Fig. 7). The complete data for this analysis are available

392    as Additional File 3.

393    These results clearly showed that the latent variable called "Former Misconduct" (FM), which

394    is defined as any experience with scientific misconduct (both passive and active) during the

395    past three years, has a strong positive correlation ($r = 0.575$) with "Last Year Misconduct"

396    (LYM), which is a higher-order variable that encompasses any recent experience with any form

397    of scientific misconduct during the last 12 months. In detail, LYM encompasses the latent

398    variables "Recent FFP Pressure" (RFP), "Recent Misconduct" (RM), "Recent Awareness"

399    (RA), "Recent QRP Pressure" (RQP), and "Recent Consequences" (RC).

400    The moderate negative correlation (r = -0.400) was found between the higher-order variable

401    LYM and another higher-order variable called "Threat" (THR), which encompasses the latent

402    variables "Common Occurrence" (CO), "High Risk of Detection" (HRD), and "Severe

403    Consequences" (SC). In other words, THR reflects scientific misconduct as a real threat to the

404    field of biomedicine in terms of its high incidence rate, high risk of detection, and serious

405    consequences for those who commit it. Similarly, we found the lower negative correlation (r =

406    -0.281) between THR and FM.

407    The latent variable "Unacceptable Misconduct" (UM), i.e., the unacceptability of both FFP and

408    QRP, positively correlates with latent variables "Reporting Obligation" (RO) (r = 0.291) and

409    "Shared Responsibility" (SR) (r = 0.154). Conversely, latent variable FM negatively correlates

410    with the latent variables RO (r = -0.296) and SR (r = -0.170).

411    Furthermore, latent variable "Reporting Obligation" RO positively correlates with latent

412    variable SR (r = 0.298), as well as with the higher-order variable THR (r = 0.271). In contrast,

413    the latent variable RO has a weak negative correlation (r = -0.243) with the higher-order

414    variable LYM.

415    The latent variable "Written Policy" (WP) positively correlates (r = 0.296) with the higher-order

416    variable THR. And vice versa, the latent variable "Written Policy" (WP) negatively correlates

417    with the higher-order variable LYM (r = -0.160) and the latent variable "Former Misconduct"

418    (FM) (r = -0.156).

419

420    **General linear model**

421    The results of the General Linear Model (GLM) for each dependent variable are summarized

422    as Additional File 4. All models included Institution, Gender, Education Level, Seniority, and

17

423    Number of Supervised PhD Candidates as fixed factors; estimated marginal means were used

424    for additional pairwise comparison with Bonferroni correction.

425    The analysis revealed that "Institutional affiliation" remained a significant predictor ($p < 0,05$)

426    for 5 out of 7 latent variables, namely FM, SR, WP, THR and LYM. However, the effect sizes

427    for the institution factor were generally small ($\omega^2$ varying from 0.007 to 0.024), suggesting that

428    while the research environment plays a role, it does not fully account for the variance in the

429    scores.

430    "Education level in research ethics" showed significant effect on FM ($F = 3.485$, $p = 0.031$, $\omega^2$

431    $= 0.007$), SR ($F = 3.863$, $p = 0.021$, $\omega2 = 0.009$), WP ($F = 9.06$, $p = 0$, $\omega2 = 0.024$), THR ($F =$

432    $6.723$, $p = 0.001$, $\omega2 = 0.017$) and LYM ($F = 3.961$, $p = 0.019$, $\omega2 = 0.009$). In estimated

433    marginal means pairwise comparison, participants with highest education in research ethics

434    refer less FM and LYM and logically higher scores of SR, WP and THR.

435    "Seniority", i.e. years spent in research, proved to be a significant predictor of FM ($F = 3.158$,

436    $p = 0.024$, $\omega2 = 0.01$), RO ($F = 3.304$, $p = 0.02$, $\omega2 = 0.01$) and WP ($F = 4.226$, $p = 0.006$, $\omega2$

437    $= 0.014$). As could be seen, effect sizes ($\omega^2$) are really low and pairwise comparisons stress little

438    bit different picture – senior researchers point more on SR, RO and WP than their younger

439    colleagues. Nevertheless, "Number of Supervised PhD Candidates" did not yield significant

440    results at all.

441    In case of "Gender", SR ($F = 8.003$, $p = 0.005$, $\omega2 = 0.01$) is affected, as women insist on shared

442    responsibility more than men.

443

444    **Discussion**

445

446    Our data provide the first systematic description of research integrity in biomedical research in

447    10 countries of Central and Eastern Europe. As already pointed out by other authors, the main

448    limitation of the research on this topic is the methodological heterogeneity, which usually does

449    not allow a correct comparison and interpretation of data collected by different research groups

450    [22].

451    The first critical point of this study was the completion rate, which ranged from 34.15 % to 2.32

452    % of target group members in a given institution or institutional unit. Although this rate seems

453    low, it is fully comparable to those published by other researchers for online surveys on research

454    integrity. For example, the nationwide study in Japan reported a response rate of 60.6 %, but

455    this value is related to the ratio of accessed to completed questionnaires [13]. If the authors of

456    this study were to use a methodology comparable to ours, their reaction rate would be 4.03%

457    and their completion rate would be 2.44 % [13]. Similarly, the completion rate in the Dutch

458    study would be 29.3 % if it referred to all members of the target group invited to participate in

459    the study [34]. In addition, the Croatian research group reported a response rate of 8 % to 15 %

460    for their online survey [23], which is also fully comparable to our study.

461    A second limitation of our study is the presence of self-selection bias. We believe that the

462    willingness to respond to inquiries about research ethics and scientific misconduct is the most

463    potent source of self-selection bias. In other words, invited individuals who understood the

464    importance of research integrity were more likely to be willing to spend time on such a survey.

465    Conversely, those who do not adhere to the principles of responsible conduct of research are

466    more likely to ignore such surveys, which may lead to underreported results, especially

467    regarding personal involvement in scientific misconduct, willingness to report problematic

468    behavior, and willingness to accept responsibility. This limitation of surveys on scientific

469    misconduct has already been addressed in previous important studies that have pointed out the

470    underestimated frequency of scientific misconduct [1, 15].

471    The demographic characteristics of our target population across biomedical research

472    institutions in 10 Central and Eastern European countries revealed certain peculiarities

473   compared to other similar studies. As expected, since our study was not conducted solely in

474   medical schools and our participants were more diverse, we found that only a quarter of our

475   respondents worked in clinical research, while three-quarters worked in basic or other research

476   areas (Fig. 1c). In contrast, the studies performed solely in medical schools reported a clear

477   prevalence of participants from clinical research area [10, 23, 25, 26, 27] with the exception of

478   PhD students at the Karolinska Institutet, where basic research also strongly prevailed [27].

479   Nevertheless, our ratio of researchers with and without a background in health professions is

480   almost equal (Fig. 1b), indicating an interdisciplinary approach to biomedical research in

481   general. Furthermore, the fact that only one-tenth of respondents completed their previous

482   studies in another country (Fig. 1d) indicates that the international affordability of biomedicine-

483   related education is still low in the countries included in our survey.

484   In terms of gender issues, the slight predominance of females in our group of respondents (Fig.

485   1a) aligns with the aforementioned studies conducted in other European countries [23, 25, 26,

486   27, 35], while other international studies have reported an inverse ratio [18, 36]. In any case,

487   these differences among regions are to be expected. Furthermore, general linear models

488   revealed in our group of respondents that women place more importance on shared

489   responsibility than men do (Additional File 4). Unfortunately, there is limited data available on

490   gender in relation to scientific integrity. However, our findings are in accordance with an

491   analysis of gender differences among authors of retracted papers in biomedical sciences, which

492   revealed the differences in women representation in relation to the retraction reason [37, 38].

493   Nevertheless, gender itself does not affect scientific integrity as such [29].

494   The majority of our respondents were experienced researchers, as approximately 60 % of them

495   reported having been in their careers for more than 10 years (Fig. 1e). This aspect, in particular,

496   makes our study valuable for mapping the state of research integrity in the field in the

497   participating countries. Not surprisingly, seniority, in terms of the number of years spent in

498    research, is a significant predictor of former misconduct, according to general linear model

499    results. Our data also showed that these senior, experienced researchers emphasize written

500    policies, reporting obligations, and shared responsibility – i.e., cultivating a favorable research

501    environment. These findings contradict the recently published results of a 10-year follow-up

502    study from Norway showing that attitudes and behaviors related to research integrity did not

503    significantly change over the course of a professional career [30]. However, this discrepancy

504    can be easily explained by difference in the length of the professional career of these two

505    cohorts: Hofmann and colleagues analyzed a period from the first year of PhD studies to 10

506    years later, i.e., early-career researchers only. In contrast, our cohort showed that the

507    aforementioned change is associated with later phases of the scientific career. Furthermore, our

508    results on seniority are in accordance with the recent findings by Brooker and Allum [39].

509    However, about half of the respondents reported having no experience supervising students

510    (Fig. 1f), which is probably due to the varying levels of involvement of institutions or their units

511    in student research training programs. It should also be emphasized that our focus on active

512    researchers who have employee status at their home institution limits the comparability of our

513    results with those of other studies performed by Hofman and colleagues using the same

514    questionnaire, because their studies were predominantly aimed at doctoral students [23, 25, 26,

515    27]. Only the Croatian study provided separate results for supervisors [23], which we used to

516    compare with our results in the discussion below.

517    The data on the research environment showed that only one-third of the respondents reported

518    receiving education in science ethics during their undergraduate or doctoral studies (Fig. 2a).

519    This situation may contrast sharply with practices in Scandinavian countries, where the

520    attendance of specialized science ethics courses or lectures during undergraduate studies varied

521    from 59 % to 76 % among different groups of respondents [25, 26, 27]. Furthermore, the general

522    linear models revealed that the highest level of education in science ethics is associated with

523 less reporting of both former and recent misconduct, as well as with a greater insistence on

524 written policies and shared responsibility. Respondents with the highest level of education in

525 science ethics also recognize problematic practices as a threat to their field of research. These

526 results clearly confirm that education in science ethics is an essential part of favorable research

527 environment that fosters research integrity. The importance of this education has been analyzed

528 in depth repeatedly [40, 41, 42], emphasizing the need for this training, especially during Ph.D.

529 studies [43, 44].

530 It should also be highlighted that 10 % of our respondents said that they did not remember

531 whether or not they received such education in science ethics when asked about one or another

532 type of study (Fig. 2a). This information is alarming because, as mentioned before, systematic

533 education in scientific ethics is a crucial part of a favorable research environment. Forgetting

534 this education by its recipients (or forgetting its absence) indicates that something went wrong

535 in this regard. Therefore, we must emphasize the importance of improving this aspect of

536 research integrity for all countries participating in our survey. In light of this, the possible role

537 of research integrity supervisors should be of special interest [45].

538 Fewer than half of our respondents reported the existence of written institutional policies on

539 sensitive issues of research integrity at their home institutions (Fig. 2b). These policies most

540 frequently addressed plagiarism, followed by rules regarding research funds (Fig. 2b).

541 Moreover, the uncertainty about the existence of such written policies, claimed by one-third to

542 one-half of respondents (Fig. 2b), should be understood as warning information for institutional

543 managements. And as our correlation matrix of latent variables revealed, these written

544 institutional policies are another important aspect of the research environment aimed at

545 preventing scientific misconduct: a negative correlation was found between the existence of

546 written policies and the reporting of recent or former experiences with misconduct (Table 6,

547 Fig. 7). The importance of various types of policies, including institutional ones, for fostering

548    of research integrity and preventing scientific misconduct was reported repeatedly [46, 47, 48]

549    and these conclusions are fully consistent with our findings.

550    The mapping of real experiences with scientific misconduct was divided into two periods:

551    recent experiences, i.e., experiences within the last 12 months (Fig. 3) and former experiences,

552    i.e., experiences within the last three years (Fig. 4). Although these two periods were mapped

553    using different types of questions, the results obtained showed significant positive correlation

554    between the latent variable "Former Misconduct" and the higher-order variable "L12" (Fig. 7),

555    as will be discussed in detail below.

556    Furthermore, the recent experience was evaluated based on the level of personal participation

557    (Fig. 3). As expected, the most frequently reported experience was awareness of another

558    person's involvement in scientific misconduct, especially in terms of misleading results

559    presentation (Fig. 3c). Meanwhile, personal active or passive engagement was stated only

560    rarely; however, misleading data presentation was also the most frequently indicated type of

561    misconduct in these subcategories (Fig. 3a-b). These findings are in accordance with older

562    meta-analysis reporting very similar frequencies to ours both for personal involvement and

563    awareness of another person's misconduct [1]. If compared with data from other studies using

564    the same questionnaire, the Croatian study found the data fabrication or falsification as the most

565    frequently reported types of misconduct, when the answers of the supervisors only were taken

566    into account due to their comparability with our group of respondents [23].

567    In contrast, the most frequently reported issue of recently experienced unethical pressure was

568    related to authorship and reaches about 30 % (Fig. 3d). This finding is comparable with data

569    from three Scandinavian universities showing that 20 % of respondents experienced pressure

570    related to authorship inclusion or ordering in the last 12 months [27]. It should also be noted

571    that, although personal engagement in scientific misconduct was reported to be very sporadic,

572    up to one-tenth of the respondents mentioned a recent confrontation or uncertainty about a

573    confrontation regarding the consequences of misconduct (Fig. 3e).

574    The scaled-response questions mapping former experiences with misconduct (Fig. 4) showed

575    that QRP issues, especially gifted authorship, N-hacking, and retention of results, were the most

576    frequently indicated. In contrast, serious misconduct, i.e., FFP issues, were sporadically

577    reported. This is partly contradictory to the findings from the Netherlands, where 10 % of

578    respondents working in life and medical sciences admitted to being involved in fabrication or

579    falsification for the same time period, i.e., within the last three years before the survey [17].

580    Nevertheless, the types of misconduct that were mentioned the least were undisclosed conflicts

581    of interest and hidden funders in publications. In other words, both were related to transparency.

582    In any case, our data revealed significantly lower frequencies of QRP compared to the meta-

583    analysis by Fanelli, in which personal involvement was 34 %, and awareness of another person's

584    misconduct was 72 % [1]. This difference could be explained by several factors. One factor is

585    the discrepancy in how QRP was defined in our study compared to those by Fanelli and

586    colleagues [1]. The second factor is the 15-year time difference between these studies. During

587    this period, awareness of research integrity requirements became widespread in the scientific

588    community, which should have led to a decline in the frequency of QRP. However, the recent

589    survey from the Netherlands revealed that 55 % of respondents working in life and medical

590    sciences were involved in any form of frequent QRP [17]. Regarding gift authorship, a recent

591    study of early-career researchers in five European countries (Denmark, Hungary, Ireland,

592    Portugal, and Switzerland) showed that 34 % of them actively engaged in this practice [35].

593    These data are in accordance with our findings and the very same frequency of gift authorship

594    was also found in the Scandinavian study [27].

595    Data on personal acceptability of various forms of misconduct (Fig. 5a) also showed that most

596    respondents clearly recognized all practices within the FFP category as unacceptable.

597    Conversely, removing outliers and p-hacking seems to be more or less acceptable practices for

598    about 20 % of respondents. Nevertheless, the most alarming information from this question

599    concerns the possibility of data manipulation in the project proposal: this practice was

600    considered more or less acceptable by 44 % of respondents, while 34 % considered it more or

601    less unacceptable. The almost identical results on data manipulation in project proposals were

602    achieved among Croatian supervisors [23]. This suggests that approximately half of the project

603    proposals may be based on intentionally manipulated data. Such a finding raises questions about

604    the meaningfulness of funding biomedical research in general.

605    Furthermore, our data showed that three-quarters of respondents found whistleblowing more or

606    less acceptable when the wrongdoer was not specified in detail. However, when the wrongdoer

607    is a colleague/peer or supervisor/PI, the acceptability of whistleblowing decreases to 60 % (Fig.

608    5b). These data are similar to the findings obtained in the Croatian study for the group of

609    supervisors. However, the researchers noted a higher willingness for whistleblowing if the

610    wrongdoer was a PI than a coworker [23]. Another large international study of eight European

611    leading research universities on the reporting of misconduct (in which the authors intentionally

612    omitted the term "whistleblowing") showed that the willingness to report a problematic

613    behavior is higher among senior researchers and is mainly related to the FFP rather than the

614    QRP [49]. Furthermore, these results align with our previous findings regarding the relationship

615    between seniority and reporting obligations, as described above.

616    The data also showed limited willingness to share the consequences of one typical FFP practice:

617    data fabrication. To share the blame in such a situation is fully or mostly unacceptable for 35

618    % of respondents and to share the punishment is fully or mostly unacceptable for 40 % of them

619    (Fig. 5b). Again, very similar results were obtained among Croatian supervisors [23].

620    The final section of the questionnaire focused on personal perceptions of scientific misconduct

621    in biomedicine (Fig. 6). Respondents estimate that authorship misconduct is the most frequent

622    type of misconduct in the field. However, it is considered to have the lowest risk of detection

623    and the least severe consequences if detected. As expected, the pattern of responses is inverse

624    for severe misconduct. These findings also correspond to those obtained in the Croatian study

625    among the supervisors [23] and with a previous study on scientific misconduct at medical

626    research centers in Belgium [50].

627    Nevertheless, the unique findings of our study came from the latent variable model showing the

628    correlations between latent and higher-order variables, which reflect important domains in the

629    A4L questionnaire (Fig. 7). The correlations found depicted the importance of the overall

630    research environment regarding scientific integrity, which is apparently interconnected with the

631    incidence of various forms of misconduct as experienced recently or in the past. This is

632    indicated by the significant negative correlation between recently experienced misconduct

633    (L12) and viewing the misconduct as a real threat to the research in the field of biomedicine

634    (higher-order variable "Threat"). Similarly, the negative correlation between "Threat" and the

635    latent variable "Former Misconduct" suggests a similar trend over the longer time period.

636    In more detail, the researchers, for whom any form of misconduct is unacceptable, understood

637    the obligation to report such behavior whenever it is detected, including misconduct committed

638    by superiors. This can be seen from positive correlation between latent variables "Unacceptable

639    Misconduct" and "Reporting Obligations". Similarly, those who understood any form of

640    misconduct as unacceptable, are ready to accept the shared responsibility of all authors for

641    published articles, as shown from positive correlation between these two latent variables. The

642    same relationship is indicated by the inverse negative correlation between each of these two

643    latent variables and previous experience with misconduct (the latent variable "Former

644    Misconduct"): those who have actively or passively experienced misconduct are less willing to

645    report it to the responsible official persons or take responsibility for the problematic behavior.

646 Furthermore, the significant positive correlation between the recent (higher-order variable L12)

647 and the past (latent variable "Former Misconduct") shows that the incidence of misconduct

648 persists over time at research institutions. In other words, this is not a sporadic or accidental

649 phenomenon.

650 Another interesting correlation involves written policies addressing various misconduct issues.

651 The existence of such a written policy (regardless of the topic covered) correlates positively

652 with the latent variable "Shared Responsibility" and with any recent experience with scientific

653 misconduct. In this context, the negative correlation between the existence of a written policy

654 (WP) and recent experience with misconduct (L12) suggests that institutions with an active

655 approach to preventing misconduct have experienced lower incidence of misconduct during the

656 last year. These findings are fully consistent with other recent studies that reported the

657 importance of favorable research environment as a key factor in strengthening research integrity

658 [28, 29, 39]. Furthermore, the role of overall research culture in improving quality of research

659 and in fostering research integrity was also highlighted in relevant literature [18, 51].

660

661 **Conclusion**

662

663 Finally, we would like to emphasize that upholding scientific integrity is not just a matter of

664 individual attitudes; it is a cornerstone of trustworthy science and a functioning research

665 community. As biomedical research increasingly influences healthcare, technological

666 advancements, and related policies, the consequences of scientific misconduct in this field

667 become more severe. Especially cases of FFP not only hinder scientific progress but also

668 undermine public confidence in research institutions. However, QRP must also be considered

669 seriously because many surveys, including ours, reveal it as much more frequent than FFP.

670 Therefore, QRP erodes the reliability of published research studies, resulting in devastating

671 consequences similar to those of FFP. Therefore, prevention measures must address the broader

672 context in which research is conducted, rather than focusing solely on the issue of FFP.

673 Our study using a latent variable model of latent variables yielded unique results clearly

674 showing that cultivating a healthy research environment is essential to reducing the risk of

675 scientific misconduct. Universities and research organizations should actively foster an research

676 environment that values honesty, truthfulness, transparency, collaboration, and integrity more

677 than mere output metrics. This includes providing education on responsible research conduct,

678 implementing fair and supportive mentorship practices, and ensuring that written policies are

679 meaningfully integrated into daily institutional life.

680

681 **Declarations**

682

683 **Ethics approval and consent to participate**

684 This study was conducted in accordance with international research guidelines and national

685 laws. The intent to conduct this survey was presented to the responsible research ethics

686 committees (RECs) at the participating research institutions and each REC was provided with

687 the full version of the A4L questionnaire along with a cover letter. As this type of research is

688 subject to different types of ethical evaluation according to specific national legislation, our

689 survey was either subjected to ethical review and approved to be conducted (Croatia, Hungary,

690 Slovenia) or a statement was issued that ethical review was not required (Bulgaria, Czechia,

691 Latvia, Lithuania, Poland, Romania, Slovakia). The following statements were issued by the

692 institutional RECs, listed in alphabetical order by country name:

693 Statement No. 3379/14.10.22 issued by the Rector of Medical University – Sofia, Bulgaria

694 Approval No. 380-59-10106-22-111/148 issued by the Ethics Committee, School of Medicine,

695 University of Zagreb, Croatia

696     Statement No. EKV-LS-2022-007 issued by the Masaryk University Research Ethics

697     Committee, Czechia

698     Approval No. 212/2022 issued by the Semmelweis University University Ethics Committee,

699     Hungary

700     Statement No. 01/22 issued by the Latvian Institute of Organic Synthesis Biomedicine Research

701     Ethics Committee, Latvia

702     Statement No. 2022-10-18 issued by the Vilnius Regional Biomedical Research Ethics

703     Committee, Lithuania

704     Statement No. RNN/261/22/KE issued by the Medical University of Lodz Bioethics

705     Committee, Poland

706     Statement No. PO-35-F-03b issued by the Research Ethics Committee, University of Medicine

707     and Pharmacy "Carol Davila", Romania

708     Statement No. 10.10.2022 issued by the Ethics Committee of Biomedical Research Center of

709     the Slovak Academy of Sciences, Slovakia

710     Approval No. 0120-428/2022/3 issued by the Medical Ethics Committee, Ministry of Health,

711     Slovenia

712     No personal data of human subjects were collected during the research and respondents

713     participated in the survey as anonymous employees of their home institutions and not as

714     identifiable individuals. Under these conditions, no written informed consent to participate was

715     obtained from the respondents. Nevertheless, respondents were informed about the

716     questionnaire in detail on the introductory screen of the survey. After reading the information,

717     they provided implicit consent to participate by clicking the "Start the Survey" button.

718

719     **Consent for publication**

720     Not applicable.

721

**Availability of data and materials**

723 Data are provided within the manuscript or the additional files. All other data related to this

724 study are available upon request from the corresponding author, Renata Veselska, at

725 veselska@mail.muni.cz

726

**Competing interests**

728 The authors declare that they have no competing interests.

729

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736 (A4L_ACTIONS).

737

**Authors' contributions**

739 RV, EG and AB conceptualized this study; AB, RV and JS adapted the questionnaire; RV, EG

740 and JS organized the invitation to participate in this survey; A4L FG2 consortium members

741 distributed the links to the questionnaires and provided information on the target group size; JS

742 administered the questionnaire and collect raw data; JS and RV analyze and interpret the data;

743 RV wrote the manuscript; JS, EG and AB critically revise the manuscript.

744

745

**References**

1. Fanelli D. How many scientists fabricate and falsify research? A systematic review and meta-analysis of survey data. PLoS One. 2009;4(5):e5738. doi:10.1371/journal.pone.0005738

2. DuBois JM, Anderson EE, Chibnall J, Carroll K, Gibb T, Ogbuka C, et al. Understanding research misconduct: A comparative analysis of 120 cases of professional wrongdoing. Account Res. 2013;20(5-6):320-38. doi:10.1080/08989621.2013.822248

3. Armond ACV, Gordijn B, Lewis J, Hosseini M, Kristof J, Holm S, et al. A scoping review of the literature featuring research ethics and research integrity cases. BMC Med Ethics. 2021;22(1):50. doi:10.1186/s12910-021-00620-8

4. Federer LM, Lu YL, Joubert DJ, Welsh J, Brandys B. Biomedical Data Sharing and Reuse: Attitudes and Practices of Clinical and Scientific Research Staff. PLoS One. 2015;10(6):e0129506. doi: 10.1371/journal.pone.0129506

5. Marsolek W, Wright SJ, Luong H, Braxton SM, Carlson J, Lafferty-Hess S. Understanding the value of curation: A survey of researcher perspectives of data curation services from six US institutions. PLoS One. 2023;18(11):e0293534. doi: 10.1371/journal.pone.0293534

6. Johnston LR, Curty R, Braxton SM, Carlson J, Hadley H, Lafferty-Hess S, et al. Understanding the value of curation: A survey of US data repository curation practices and perceptions. PLoS One. 2024;19(6):e0301171. doi: 10.1371/journal.pone.0301171

7. Head ML, Holman L, Lanfear R, Kahn AT, Jennions MD. The extent and consequences of p-hacking in science. PLoS Biol. 2015;13(3):e1002106. doi: 10.1371/journal.pbio.1002106

8. Andrade C. HARKing, Cherry-Picking, P-Hacking, Fishing Expeditions, and Data Dredging and Mining as Questionable Research Practices. J Clin Psychiatry. 2021;82(1):20f13804. doi:10.4088/JCP.20f13804

770    9.  Stefan AM, Schönbrodt FD. Big little lies: a compendium and simulation of *p*-hacking

771        strategies. R Soc Open Sci. 2023;10(2):220346. doi:10.1098/rsos.220346

772    10. Nylenna M, Fagerbakk F, Kierulf P. Authorship: attitudes and practice among Norwegian

773        researchers. BMC Med Ethics. 2014;15:53. doi:10.1186/1472-6939-15-53

774    11. Resnik DB, Rasmussen LM, Kissling GE. An international study of research misconduct

775        policies. Account Res 2015;22:249-66. doi:10.1080/08989621.2014.958218

776    12. Forsberg EM, Anthun FO, Bailey S, Birchley G, Bout H, Casonato C, et al. Working with

777        research integrity – guidance for research performing organisations: The Bonn

778        PRINTEGER statement. Sci Eng Ethics. 2018;24(4),1023-34. doi:10.1007/s11948-018-

779        0034-4

780    13. Nishimura R, Takeuchi J, Sakuma M, Uchida K, Higaonna M, Kinjo N, et al. Experience

781        and awareness of research integrity among Japanese physicians: a nationwide cross-

782        sectional study. BMJ Open. 2021;11(10):e052351. doi:10.1136/bmjopen-2021-052351

783    14. Yu L, Miao M, Liu W, Zhang B, Zhang P. Scientific misconduct and associated factors: A

784        survey of researchers in three Chinese tertiary hospitals. Account Res. 2021;28(2):95-114.

785        doi:10.1080/08989621.2020.1809386

786    15. Kaiser M, Drivdal L, Hjellbrekke J, Ingierd H, Rekdal OB. Questionable Research Practices

787        and Misconduct Among Norwegian Researchers. Sci Eng Ethics. 2021;28(1):2.

788        doi:10.1007/s11948-021-00351-4

789    16. Armond ACV, Kakuk P. Perceptions of Research Integrity Climate in Hungarian

790        Universities: Results from A Survey among Academic Researchers. Sci Eng Ethics.

791        2022;28(4):30. doi:10.1007/s11948-022-00382-5

792    17. Gopalakrishna G, Ter Riet G, Vink G, Stoop I, Wicherts JM, Bouter LM. Prevalence of

793        questionable research practices, research misconduct and their potential explanatory

794 factors: A survey among academic researchers in The Netherlands. PLoS One.
795 2022;17(2):e0263023. doi:10.1371/journal.pone.0263023

796 18. Schneider JW, Allum N, Andersen JP, Petersen MB, Madsen EB, Mejlgaard N, et al. Is
797 something rotten in the state of Denmark? Cross-national evidence for widespread
798 involvement but not systematic use of questionable research practices across all fields of
799 research. PLoS One. 2024;19(8):e0304342. doi:10.1371/journal.pone.0304342

800 19. Yi N, Nemery B, Dierickx K. Integrity in Biomedical Research: A Systematic Review of
801 Studies in China. Sci Eng Ethics. 2019;25(4):1271-301. doi:10.1007/s11948-018-0057-x

802 20. Xie Y, Wang K, Kong Y. Prevalence of research misconduct and questionable research
803 practices: A systematic review and meta-analysis. Sci Eng Ethics. 2021;27(4):41.
804 doi:10.1007/s11948-021-00314-9

805 21. Phogat R, Manjunath BC, Sabbarwal B, Bhatnagar A, Reena, Anand D. Misconduct in
806 Biomedical Research: A Meta-Analysis and Systematic Review. J Int Soc Prev Community
807 Dent. 2023;13(3):185-93. doi:10.4103/jispcd.JISPCD_220_22

808 22. Marusic A, Wager E, Utrobicic A, Rothstein HR, Sambunjak D. Interventions to prevent
809 misconduct and promote integrity in research and publication. Cochrane Database Syst Rev.
810 2016;4(4):MR000038. doi:10.1002/14651858.MR000038.pub2

811 23. Ljubenković AM, Borovečki A, Ćurković M, Hofmann B, Holm S. Survey on the Research
812 Misconduct and Questionable Research Practices of Medical Students, PhD Students, and
813 Supervisors at the Zagreb School of Medicine in Croatia. J Empir Res Hum Res Ethics.
814 2021;16(4):435-49. doi:10.1177/15562646211033727

815 24. Jensen LB, Kyvik KO, Leth-Larsen R, Eriksen MB. Research integrity among PhD students
816 within clinical research at the University of Southern Denmark. Dan Med J.
817 2018;65(4):A5469.

818   25. Hofmann B, Myhr AI, Holm S. Scientific dishonesty – a nationwide survey of doctoral
819       students in Norway. BMC Med Ethics. 2013;14:3. doi:10.1186/1472-6939-14-3

820   26. Hofmann B, Helgesson G, Juth N, Holm S. Scientific Dishonesty: A Survey of Doctoral
821       Students at the Major Medical Faculties in Sweden and Norway. J Empir Res Hum Res
822       Ethics. 2015;10(4):380-8. doi:10.1177/1556264615599686

823   27. Hofmann B, Bredahl Jensen L, Eriksen MB, Helgesson G, Juth N, Holm S. Research
824       Integrity Among PhD Students at the Faculty of Medicine: A Comparison of Three
825       Scandinavian Universities. J Empir Res Hum Res Ethics. 2020;15(4):320-9.
826       doi:10.1177/1556264620929230

827   28. Hofmann B, Holm S. Research integrity: Environment, experience, or ethos? Res Ethics.
828       2019;15(3-4):1-13. doi:10.1177/1747016119880844

829   29. Fanelli D, Costas R, Larivière V. Misconduct Policies, Academic Culture and Career Stage,
830       Not Gender or Pressures to Publish, Affect Scientific Integrity. PLoS One.
831       2015;10(6):e0127556. doi:10.1371/journal.pone.0127556

832   30. Hofmann B, Thoresen M, Holm S. Research Integrity Attitudes and Behaviors are Difficult
833       to alter: Results from a ten Year Follow-up Study in Norway. J Empir Res Hum Res Ethics.
834       2023;18(1-2):50-7. doi:10.1177/15562646221150032

835   31. National Information Standards Organization (NISO): Contributor Role Taxonomy
836       (CRediT) https://credit.niso.org/ (2022). Accessed 28 Jun 2025.

837   32. European Network for Academic Integrity (ENAI): Glossary for Academic Integrity.
838       https://www.academicintegrity.eu/wp/glossary/ (2022). Accessed 28 Jun 2025.

839   33. Little TD, Cunningham WA, Shahar G, Widaman KF. To parcel or not to parcel: Exploring
840       the question, weighing the merits. Struct Equ Model. 2002;9(2):151-173.
841       doi:10.1207/S15328007SEM0902_1

842    34. Tijdink J, Bouter L, Veldkamp C, van de Ven P, Wicherts J, Smulders Y. Personality traits

843        are associated with research misbehavior in Dutch scientists: A cross-sectional study. PLoS

844        One. 2016;11(9):e0163251. doi:10.1371/journal.pone.0163251

845    35. Goddiksen MP, Johansen MW, Armond AC, Clavien C, Hogan L, Kovács N, et al. "The

846        person in power told me to" – European PhD students' perspectives on guest authorship and

847        good    authorship    practice.    PLoS    One.    2023;18(1):e0280018.

848        doi:10.1371/journal.pone.0280018

849    36. Schroter S, Roberts J, Loder E, Penzien DB, Mahadeo S, Houle TT. Biomedical authors'

850        awareness of publication ethics: an international survey. BMJ Open. 2018;8(11):e021282.

851        doi:10.1136/bmjopen-2017-021282

852    37. Pinho-Gomes AC, Hockham C, Woodward M: Women's representation as authors of

853        retracted papers in the biomedical sciences PLoS One. 2023;18(5):e0284403.

854        doi:10.1371/journal.pone.0284403

855    38. Zheng ET, Fu HZ, Thelwall M, Fang Z. (2025). Do male leading authors retract more

856        articles    than    female    leading    authors?    J    Informetr.    2025;19(3):101682.

857        doi:10.1016/j.joi.2025.101682

858    39. Brooker R, Allum N. Investigating the links between questionable research practices,

859        scientific norms and organisational culture. Res Integr Peer Rev. 2024;9(1):12.

860        doi:10.1186/s41073-024-00151-x

861    40. Pizzolato D, Dierickx K. Stakeholders' perspectives on research integrity training practices:

862        a qualitative study. BMC Med Ethics. 2021;22(1):67. doi:10.1186/s12910-021-00637-z

863    41. Labib K, Evans N, Roje R, Kavouras P, Elizondo AR, Kaltenbrunner W, et al. Education

864        and training policies for research integrity: Insights from a focus group study. Sci Publ

865        Policy. 2022;49(2):246-66. doi:10.1093/scipol/scab077

866    42. Crean D, Gordijn B, Kearns AJ. Teaching research integrity as discussed in research
867        integrity codes: A systematic literature review. Account Res. 2025;32(3):369-392. doi:
868        10.1080/08989621.2023.2282153

869    43. Pizzolato D, Abdi S, Dierickx K. Collecting and characterizing existing and freely
870        accessible research integrity educational resources. Account Res. 2020;27(4):195-211.
871        doi:10.1080/08989621.2020.1736571

872    44. Abdi S, Pizzolato D, Nemery B, Dierickx. Educating PhD Students in Research Integrity in
873        Europe. Sci Eng Ethics. 2021;27(1):5. doi:10.1007/s11948-021-00290-0

874    45. Pizzolato D, Dierickx K. Research Integrity Supervision Practices and Institutional Support:
875        A Qualitative Study. J Acad Ethics. 2023;21:427-448. doi:10.1007/s10805-022-09468-y

876    46. Resnik DB, Master Z. Policies and initiatives aimed at addressing research misconduct in
877        high-income countries. PLoS Med. 2013;10(3):e1001406.
878        doi:10.1371/journal.pmed.1001406

879    47. Resnik DB, Ariansen JL, Jamal J, Kissling GE. Institutional Conflict of Interest Policies at
880        U.S. Academic Research Institutions. Acad Med. 2016;91(2):242-6.
881        doi:10.1097/ACM.0000000000000980

882    48. Li D, Cornelis G. Defining and Handling Research Misconduct: A Comparison Between
883        Chinese and European Institutional Policies. J Empir Res Hum Res Ethics. 2020;15(4):302-
884        319. doi:10.1177/1556264620927628

885    49. Horbach SPJM, Breit E, Halffman W, Mamelund SE. On the Willingness to Report and the
886        Consequences of Reporting Research Misconduct: The Role of Power Relations. Sci Eng
887        Ethics. 2020;26(3):1595-1623. doi:10.1007/s11948-020-00202-8

888    50. Tijdink JK, Verbeke R, Smulders YM. Publication Pressure and Scientific Misconduct in
889        Medical Scientists. J Empir Res Hum Res Ethics. 2014;9(5):64-71.
890        doi:10.1177/1556264614552421

891    51. Mejlgaard N, Bouter LM, Gaskell G, Kavouras P, Allum N, Bendtsen AK, et al. Research

892        integrity: nine ways to move from talk to walk. Nature. 2020;586(7829):358-360.

893        doi:10.1038/d41586-020-02847-8

894

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916

917 **Figure captions**

918

919 Figure 1: Demographic and professional characteristics of the respondents.

920

921 Figure 2: Research environment in the area of research ethics and research integrity.

922

923 Figure 3: Personal experiences with scientific misconduct in the past 12 months.

924

925 Figure 4: Three-year personal experiences with different forms of scientific misconduct.

926

927 Figure 5: Personal acceptability of various forms and consequences of scientific misconduct.

928

929 Figure 6: Personal estimation of misconduct in one's own field of research.

930

931 Figure 7: Confirmatory factor analysis plot summarizing the significant correlations. Latent variables

932 (black) and higher-order variables (dark blue) are shown as spheres. Significant positive correlations

933 (r>0.150, green) and negative correlations (r<-0.150, red) are shown as connecting lines. Line thickness is

934 proportional to the absolute value of the correlation coefficient (r). Latent variables included: former

935 misconduct, FM; reporting obligation RO; shared responsibility, SR; unacceptable misconduct, UM;

936 written policies, WP. Higher-order variables: last-year misconduct, LYM; threat, THR.

937

938 **Additional files**

939

940 **Additional File 1**

941 File name and format: Veselska Additional File 1.pdf

942  Invitation letter from the Chair and Co-Chair of A4L Focus Group 2 to participate in the survey.

943

**Additional File 2**

945  File name and format: Veselska Additional File 2.pdf

946  Full version of the A4L Questionnaire.

947

948  **Additional File 3**

949  File name and format: Veselska Additional File 3.pdf

950  All data related to the confirmatory factor analysis.

951

952  **Additional File 4**

953  File name and format: Veselska Additional File 4.pdf

954  All data related to the general linear model (MANOVA).

955

956  **Tables**

957

958  **Table 1: Overview of the institutions and target groups addressed.**

| Institution name (acronyme) and location | Target group size | Start date | End date |
|---|---|---|---|
| Institution / Institutional Unit details | | | |
| **Biomedical Research Center of the Slovak Academy of Sciences (BMC SAS), Bratislava, Slovakia** | | | |
| BMC SAS *(no internal organizational units)* | 315 | 21.11.2022 | 20.3.2023 |
| **International Clinical Research Center (ICRC), St. Anne's University Hospital, Brno, Czechia** | | | |
| ICRC *(no internal organizational units)* | No response to invitation. | | |
| **Latvian Institute of Organic Synthesis (LIOS), Riga, Latvia** | | | |
| LIOS *(no internal organizational units)* | 195 | 17.10.2022 | 13.2.2023 |

| Masaryk University (MUNI), Brno, Czechia | | | |
|---|---|---|---|
| MUNI Central European Institute of Technology | 475 | 16.12.2022 | 14.4.2023 |
| MUNI Faculty of Science | 407 | 26.10.2022 | 22.2.2023 |
| MUNI Faculty of Pharmacy | 90 | 26.10.2022 | 22.2.2023 |
| MUNI Faculty of Medicine | No response to invitation. | | |
| **Medical University of Lodz (MUL), Lodz, Poland** | | | |
| MUL Faculty of Health Sciences | 129 | 25.11.2022 | 24.3.2023 |
| MUL Faculty of Medicine and Dentistry | 507 | 26.11.2022 | 25.3.2023 |
| MUL Faculty of Pharmacy | 82 | 25.11.2022 | 24.3.2023 |
| **Medical University Sofia (MUS), Sofia, Bulgaria** | | | |
| MUS Faculty of Dental Medicine | 345 | 28.10.2022 | 24.2.2023 |
| MUS Faculty of Medicine | 459 | 28.10.2022 | 24.2.2023 |
| MUS Faculty of Pharmacy | 200 | 28.10.2022 | 24.2.2023 |
| MUS Public Health and Care | 211 | 28.10.2022 | 24.2.2023 |
| **Semmelweis University (SU), Budapest, Hungary** | | | |
| SU Faculty of Dentistry | 381 | 15.11.2022 | 14.3.2023 |
| SU Faculty of Medicine | 123 | 21.11.2022 | 20.3.2023 |
| SU Faculty of Pharmaceutical Sciences | NA | 20.12.2022 | 18.4.2023 |
| **University of Ljubljana (UL), Ljubljana, Slovenia** | | | |
| UL Faculty of Medicine | 351 | 12.12.2022 | 10.4.2023 |
| **University of Medicine and Pharmacy "Carol Davila" (UMFCD), Bucharest, Romania** | | | |
| UMFCD Faculty of Dentistry | NA | 3.11.2022 | 2.3.2023 |
| UMFCD Faculty of Medicine | No response to invitation. | | |

| UMFCD Faculty of Pharmacy | | NA | 31.10.2022 | 27.2.2023 |
|---|---|---|---|---|
| **University of Tartu (UT), Tartu, Estonia** | | | | |
| UT | Decision not to participate. | | | |
| **University of Zagreb (UZ), Zagreb, Croatia** | | | | |
| UZ School of Medicine | | 517 | 20.10.2022 | 16.2.2023 |
| **Vilnius University (VU), Vilnius, Lithuania** | | | | |
| VU Center for Life Sciences | | 282 | 21.11.2022 | 20.3.2023 |
| VU Faculty of Medicine | | 466 | 21.11.2022 | 20.3.2023 |

959

960 **Table 2: Response rate achieved.** Response rate was calculated as the ratio of the completion rate to the

961 reaction rate. Reaction rate is the number of participants who opened the online A4L Questionnaire using

962 the link provided in the invitation e-mail. Completion rate is the number of respondents who fulfilled the

963 entire questionnaire. Only institutions and institutional units willing to participate in the survey are

964 included.

| Institution / Institutional Unit | Target group | Reaction rate | | Completion rate | | Response rate |
|---|---|---|---|---|---|---|
| BMC SAS | 315 | 128 | 40.63 % | 76 | 24.13 % | 0.59 |
| LIOS | 195 | 106 | 54.36 % | 49 | 25.13 % | 0.46 |
| MUNI CEITEC Institute | 475 | 79 | 16.63 % | 38 | 8.00 % | 0.48 |
| MUNI Faculty of Science | 407 | 153 | 37.59 % | 81 | 19.90 % | 0.53 |
| MUNI Faculty of Pharmacy | 90 | 34 | 37.78 % | 15 | 16.67 % | 0.44 |
| MUL Faculty of Health Sciences | 129 | 43 | 33.33 % | 17 | 13.18 % | 0.40 |
| MUL Faculty of Medicine and Dentistry | 507 | 27 | 5.33 % | 13 | 2.56 % | 0.48 |

| | | | | | | |
|---|---|---|---|---|---|---|
| MUL Faculty of Pharmacy | 82 | 12 | 14.63 % | 5 | 6.10 % | 0.42 |
| MUS Faculty of Dental Medicine | 345 | 28 | 8.12 % | 8 | 2.32 % | 0.29 |
| MUS Faculty of Medicine | 459 | 62 | 13.51 % | 33 | 7.19 % | 0.53 |
| MUS Faculty of Pharmacy | 200 | 15 | 7.50 % | 7 | 3.50 % | 0.47 |
| MUS Public Health and Care | 211 | 23 | 10.90 % | 14 | 6.64 % | 0.61 |
| SU Faculty of Dentistry | 381 | 24 | 6.30 % | 9 | 2.36 % | 0.38 |
| SU Faculty of Medicine | 123 | 88 | 71.54 % | 42 | 34.15 % | 0.48 |
| SU Faculty of Pharmaceutical Sciences | NA | 6 | NA | 3 | NA | 0.50 |
| UL Faculty of Medicine | 351 | 117 | 33.33 % | 79 | 22.51 % | 0.68 |
| UMFCD Faculty of Dentistry | NA | 39 | NA | 27 | NA | 0.69 |
| UMFCD Faculty of Pharmacy | NA | 65 | NA | 35 | NA | 0.54 |
| UZ School of Medicine | 517 | 123 | 23.79 % | 81 | 15.67 % | 0.66 |
| VU Center for Life Sciences | 282 | 104 | 36.88 % | 53 | 18.79 % | 0.51 |
| VU Faculty of Medicine | 466 | 121 | 25.97 % | 67 | 14.38 % | 0.55 |

965

966 **Table 3: Scientific role(s) of the respondents.** The categories of the Contributor Role Taxonomy
967 (CRediT) were used in this question (Q19) and the question was administered as multiple-choice.

| Role according to CRediT (listed in alphabetical order) | Percentage of respondents who identified themselves with the role |
|---|---|
| Conceptualization | 75.7 % |
| Data curation | 28.2 % |
| Formal analysis | 53.9 % |
| Funding acquisition | 42.7 % |
| Investigation | 79.4 % |
| Methodology | 75.0 % |
| Project administration | 40.0 % |

| Resources | 47.3 % |
|---|---|
| Software | 12.8 % |
| Supervision | 53.1 % |
| Validation | 42.0 % |
| Visualization | 64.6 % |
| Writing – Original Draft | 82.8 % |
| Writing – Review & Editing | 73.5 % |

968

969 **Table 4: List of items in the model of latent variables.** The "Parcel assignment" column indicates the
970 specific parcel to which a variable was allocated.

| Acronym and description of the latent variable | No. of the answer included | Parcel assignment | Description of situation or behavior covered by this latent variable |
|---|---|---|---|
| **RECENT FFP PRESSURE (RFP)** <br> Respondent experienced pressure to do FFP recently, i.e. within the last 12 months. | A10_1 | RFP_1 | Object of pressure: Fabricate data |
| | A10_2 | RFP_2 | Object of pressure: Falsify data |
| | A10_3 | RFP_1 | Object of pressure: Plagiarize data |
| | A10_4 | RFP_2 | Object of pressure: Plagiarize publications (in whole or in part) |
| **RECENT MISCONDUCT (RM)** <br> Respondent performed misconduct (FFP or QRP) recently, i.e. within the last 12 months. | A11_1 | RM_1 | Have you: Fabricated data |
| | A11_2 | RM_2 | Have you: Falsified data |
| | A11_3 | RM_2 | Have you: Plagiarized data |
| | A11_4 | RM_1 | Have you: Plagiarized publications (in whole or in part) |
| | A11_5 | RM_3 | Have you: Presented results in some other misleading way |
| **RECENT AWARENESS (RA)** <br> Respondent is aware of FFP or QRP done by anyone else recently, i.e. within the last 12 months. | A12_1 | RA_1 | Anyone: Fabricated data |
| | A12_2 | RA_2 | Anyone: Falsified data |
| | A12_3 | RA_1 | Anyone: Plagiarized (in any way) |
| | A12_4 | RA_2 | Anyone: Presented results in some other misleading way |
| **RECENT QRP PRESSURE (RQP)** <br> Respondent experienced pressure to perform QRP recently, i.e. within the last 12 months. | A10_5 | RQP_3 | Object of pressure: Present results in some other misleading way |
| | A13_1 | RQP_1 | Exposed: Inclusion or ordering of authors |
| | A13_2 | RQP_2 | Exposed: Design/method |

| | | | |
|---|---|---|---|
| | A13_3 | RQP_3 | Exposed: Analysis |
| | A13_4 | RQP_1 | Exposed: Results |
| **RECENT CONSEQUENCES (RC)**<br>Respondent experienced consequences of scientific misconduct recently, i.e., within the last 12 months. | A14_1 | RC_1 | Affected: Ethical |
| | A14_2 | RC_2 | Affected: Legal |
| | A14_3 | RC_1 | Affected: Methodological |
| | A14_4 | RC_2 | Affected: Any other aspect |
| **FORMER MISCONDUCT (FM)**<br>Respondent reported any experience (active or passive) with scientific misconduct (FFP or QRP) within the last three years. | A15_1 | FM_1 | Fabricated data? |
| | A15_2 | FM_2 | To confirm a hypothesis, selectively deleted or changing data after performing data analysis? |
| | A15_3 | FM_3 | Deleted data before performing data analysis? |
| | A15_4 | FM_1 | Concealed results that contradicted previous research you published? |
| | A15_5 | FM_2 | Used phrases or ideas of others without their permission? |
| | A15_6 | FM_3 | Used/ing phrases or ideas of others without citation? |
| | A15_7 | FM_1 | Turned a blind eye to colleagues' use of flawed data or questionable interpretation of data? |
| | A15_8 | FM_2 | Modified the results or conclusions of a study under pressure from an organization that (co-) funded the research? |
| | A15_9 | FM_3 | Not published (part of) the results of a study? |
| | A15_10 | FM_1 | Deliberately not mentioned an organization that funded your research in the publication of your study? |
| | A15_11 | FM_2 | Added one or more authors to a report who did not qualify for authorship (honorary author)? |
| | A15_12 | FM_3 | Selectively modified data after performing data analysis to confirm a hypothesis? |
| | A15_13 | FM_1 | Reported/ing a downwardly rounded p value (e.g. reporting that a p value of .054 is less than .05)? |
| | A15_14 | FM_2 | Reported an unexpected finding as having been hypothesized from the start? |
| | A15_15 | FM_3 | Decided whether to exclude data after looking at the impact of doing so on the results? |
| | A15_16 | FM_1 | Decided to collect more data after seeing that the results were almost statistically significant? |

44

| | A15_17 | FM_2 | Omitted a contributor who deserved authorship from the author's list? |
|---|---|---|---|
| | A15_18 | FM_3 | Stopped collecting data earlier than planned because the result at hand already reached statistical significance without formal stopping rules? |
| | A15_19 | FM_1 | Deliberately failed to mention important aspects of the study in the paper? |
| | A15_20 | FM_2 | Not disclosed a relevant financial or intellectual conflict of interest? |
| | A15_21 | FM_3 | Spread results over more papers than needed to publish more papers ('salami slicing')? |
| | A15_22 | FM_1 | Used confidential reviewer information for own research or publications? |
| **UNACCEPTABLE MISCONDUCT (UM)** Respondent identified some FFP or QRP practices as never appropriate. | A16_1 | UM_1 | It is never appropriate to report experimental data that have been created without actually having conducted the experiment. |
| | A16_2 | UM_2 | It is never appropriate to alter experimental data to make an experiment look better than it actually was. |
| | A16_3 | UM_3 | It is never appropriate to try a variety of different methods of analysis until one is found that yields a result that is statistically significant. |
| | A16_4 | UM_1 | It is never appropriate to take credit for the words or writing of someone else. |
| | A16_5 | UM_2 | It is never appropriate to take credit for the data generated by someone else. |
| | A16_6 | UM_3 | It is never appropriate to take credit for the ideas generated by someone else. |
| **SELF-JUSTIFIED MISCONDUCT (SJM)** Respondent indicated some FFP or QRP practices as acceptable under certain conditions. | A16_7 | SJM_1 | If you are confident of your findings, it is acceptable to selectively omit contradictory results to expedite publication. |
| | A16_8 | SJM_2 | If you are confident of your findings, it is acceptable to falsify or fabricate data to expedite publication. |
| | A16_9 | SJM_3 | It is more important that data reporting be completely truthful in a publication than in a grant application. |
| **REPORTING OBLIGATION (RO)** Respondent accepted the obligation to act in case of witnessed misconduct. | A16_10 | RO_1 | If you witness someone committing research misconduct, you have an ethical obligation to act. |
| | A16_11 | RO_2 | If you had witnessed a co-worker or peer committing research misconduct, you would be willing to report that misconduct to a responsible official. |

| | | | |
|---|---|---|---|
| | A16_12 | RO_3 | If you had witnessed a supervisor or principal investigator committing research misconduct, you would be willing to report that misconduct to a responsible official. |
| **SHARED RESPONSIBILITY (SR)** Respondent accepted shared responsibility for a published paper. | A16_13 | SR_1 | If fabricated data are discovered in a published paper, all co-authors must equally share in the blame. |
| | A16_14 | SR_2 | If fabricated data are discovered in a published paper, all co-authors must get the same punishment. |
| **COMMON OCCURRENCE (CO)** Respondent estimated various forms of misconduct to be common in his/her area of research. | A17_1 | CO_1 | Severe scientific misconduct (fabrication, falsification, plagiarism) is common in my area of research. |
| | A17_2 | CO_2 | Less severe scientific misconduct (less than fabrication, falsification, plagiarism) is common in my area of research. |
| | A17_3 | CO_3 | Authorship misconduct (inappropriate authorship) is common in my area of research. |
| **HIGH RISK OF DETECTION (HRD)** Respondent indicated a high risk of being detected in case of various forms of misconduct. | A17_4 | HRD_1 | The risk of being detected if you commit severe scientific misconduct in my area of research is high. |
| | A17_5 | HRD_2 | The risk of being detected if you commit less severe scientific misconduct in my area of research is high. |
| | A17_6 | HRD_3 | The risk of being detected if you commit authorship misconduct in my area of research is high. |
| **SEVERE CONSEQUENCES (SC)** Respondent expected severe consequences of being detected in committing various forms of misconduct. | A17_7 | SC_1 | The consequences of being detected if you commit severe scientific misconduct in my area of research are severe (loss of scientific career, loss of funding, retraction of publications) |
| | A17_8 | SC_2 | The consequences of being detected if you commit less severe scientific misconduct in my area of research are severe |
| | A17_9 | SC_3 | The consequences of being detected if you commit authorship misconduct in my area of research are severe |
| **WRITTEN POLICY (WP)** Respondent reported the written policies covering various types of scientific misconduct in his/her department. | Q21_1 | WP_1 | Policy: Application for funds |
| | Q21_2 | WP_2 | Policy: Use of funds |
| | Q21_3 | WP_3 | Policy: Changes in design/method |
| | Q21_4 | WP_1 | Policy: Changes in results |
| | Q21_5 | WP_2 | Policy: Fabrication of data |
| | Q21_6 | WP_3 | Policy: Falsification of data |

| | Q21_7 | WP_1 | Policy: Handling of scientific authorship |
| | Q21_8 | WP_2 | Policy: Plagiarism |
| | Q21_9 | WP_3 | Policy: Duplicate publication (publishing the same twice) |
| | Q21_10 | WP_1 | Policy: Harassment |

971

972 **Table 5: Latent variables and parcel factor loadings.** The "Factor loading" column displays the
973 standardized regression coefficient by which the respective parcel loads onto the given factor.

| Acronym and description of the latent variable | Parcel | Factor loading |
|---|---|---|
| **RECENT FFP PRESSURE** **(RFP)** Respondent experienced pressure to do FFP recently, i.e. within the last 12 months. | RFP_1 | 0.738 |
| | RFP_2 | 0.825 |
| **RECENT MISCONDUCT** **(RM)** Respondent performed misconduct (FFP or QRP) recently, i.e. within the last 12 months. | RM_1 | 0.725 |
| | RM_2 | 0.805 |
| | RM_3 | 0.421 |
| **RECENT AWARENESS** **(RA)** Respondent is aware of FFP or QRP done by anyone else recently, i.e. within the last 12 months. | RA_1 | 0.805 |
| | RA_2 | 0.946 |
| **RECENT QRP PRESSURE** **(RQP)** Respondent experienced pressure to perform QRP recently, i.e. within the last 12 months. | RQP_1 | 0.603 |
| | RQP_2 | 0.649 |
| | RQP_3 | 0.824 |
| **RECENT CONSEQUENCES** **(RC)** Respondent experienced consequences of scientific misconduct recently, i.e., within the last 12 months. | RC_1 | 0.830 |
| | RC_2 | 0.792 |
| **FORMER MISCONDUCT** **(FM)** Respondent reported any experience (active or passive) with scientific misconduct (FFP or QRP) within the last three years. | FM_1 | 0.846 |
| | FM_2 | 0.787 |
| | FM_3 | 0.793 |
| **UNACCEPTABLE MISCONDUCT** **(UM)** Respondent identified some FFP or QRP practices as never appropriate. | UM_1 | 0.894 |
| | UM_2 | 0.948 |
| | UM_3 | 0.806 |
| **SELF-JUSTIFIED MISCONDUCT** **(SJM)** Respondent indicated some FFP or QRP practices as acceptable under certain conditions. | SJM_1 | 0.866 |
| | SJM_2 | 0.823 |
| | SJM_3 | 0.370 |
| **REPORTING OBLIGATION** **(RO)** Respondent accepted the obligation to act in case of witnessed misconduct. | RO_1 | 0.706 |
| | RO_2 | 0.937 |
| | RO_3 | 0.891 |
| **SHARED RESPONSIBILITY** **(SR)** Respondent accepted shared responsibility for a published paper. | SR_1 | 0.971 |
| | SR_2 | 0.907 |

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| | | |
|---|---|---|
| **COMMON OCCURRENCE** <br> **(CO)** <br> Respondent estimated various forms of misconduct to be common in his/her area of research. | CO_1 | 0.792 |
| | CO_2 | 0.908 |
| | CO_3 | 0.659 |
| **HIGH RISK OF DETECTION** <br> **(HRD)** <br> Respondent indicated a high risk of being detected in case of various forms of misconduct. | HRD_1 | 0.851 |
| | HRD_2 | 0.957 |
| | HRD_3 | 0.708 |
| **SEVERE CONSEQUENCES** <br> **(SC)** <br> Respondent expected severe consequences of being detected in committing various forms of misconduct. | SC_1 | 0.838 |
| | SC_2 | 0.970 |
| | SC_3 | 0.839 |
| **WRITTEN POLICY** <br> **(WP)** <br> Respondent reported the written policies covering various types of scientific misconduct in his/her department. | WP_1 | 0.933 |
| | WP_2 | 0.930 |
| | WP_3 | 0.942 |

974

975 **Table 6: Correlation matrix with significant relationships among latent variables and higher-order**
976 **variables.** Higher-order variables are indicated by asterisks. Significant positive correlations are indicated
977 by light green background, significant negative correlations by light red background.

| Variable | FM | RO | SR | UM | WP | *LYM | *THR |
|---|---|---|---|---|---|---|---|
| **FM** | 1 | -0.296 | -0.170 | -0.148 | -0.156 | 0.575 | -0.281 |
| **RO** | -0.296 | 1 | 0.298 | 0.291 | 0.128 | -0.243 | 0.271 |
| **SR** | -0.170 | 0.298 | 1 | 0.154 | 0.021 | -0.104 | 0.196 |
| **UM** | -0.148 | 0.291 | 0.154 | 1 | 0.034 | -0.034 | 0.106 |
| **WP** | -0.156 | 0.128 | 0.021 | 0.034 | 1 | -0.160 | 0.296 |
| **\*LYM** | 0.575 | -0.243 | -0.104 | -0.034 | -0.160 | 1 | -0.400 |
| **\*THR** | -0.281 | 0.271 | 0.196 | 0.106 | 0.296 | -0.400 | 1 |

978

(a) Gender

health profession
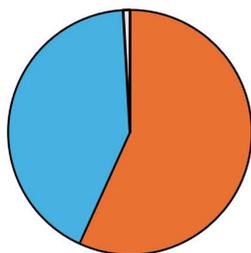
Ph.D. studies
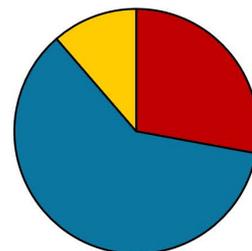
Female
Male
Not disclosed
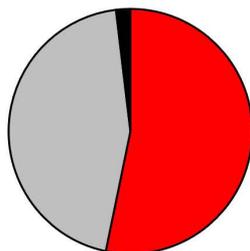
Yes
No
Not disclosed

Clinical
Basic
Other

(d) Country of previous studies

Undergraduate studies
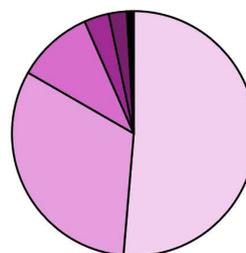Doctoral studies

Same country
Elsewhere
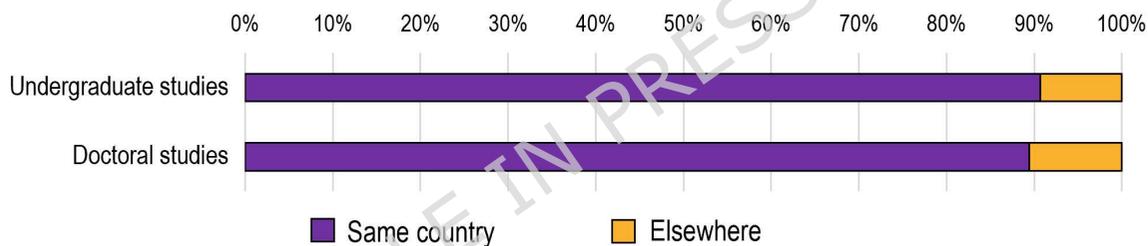
(e) Lenght of career
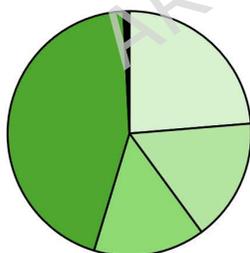
0-5 years
6-10 years
11-15 years
>15 years
Not disclosed

(f) Supervisory experience

None
1-5 students
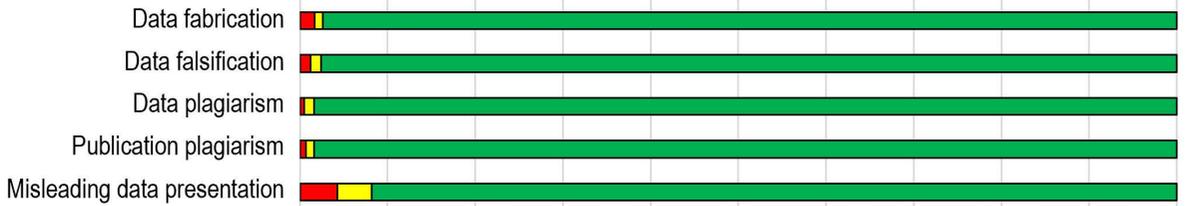6-10 students
11-15 students
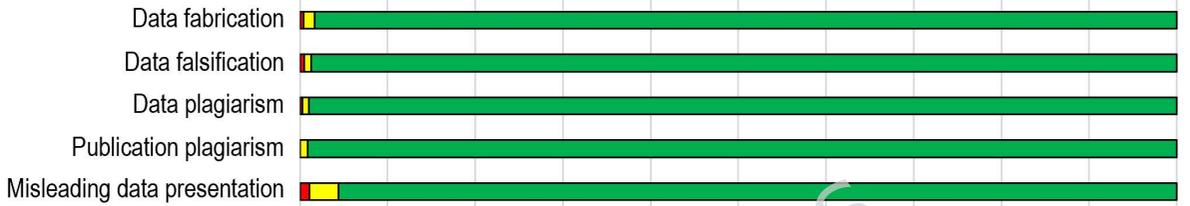>15 students
Not disclosed

(a) Passive expo... ARTICLE IN PRESS

- Data fabrication
- Data falsification
- Data plagiarism
- Publication plagiarism
- Misleading data presentation

(b) Active engagement

- Data fabrication
- Data falsification
- Data plagiarism
- Publication plagiarism
- Misleading data presentation

(c) Awareness of someone else

- Data fabrication
- Data falsification
- Plagiarism
- Misleading result presentation

(d) Unethical pressure

- Inclusion or ordering of authors
- Design / Method
- Analysis
- Results
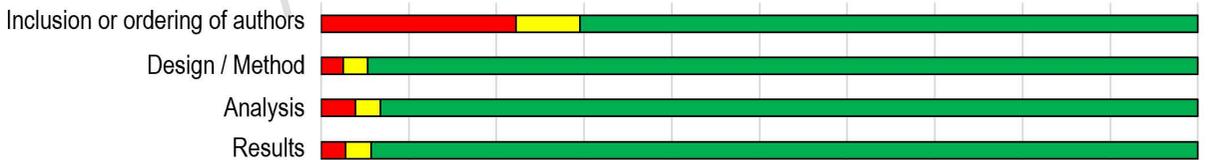
(e) Confrontation with consequences

- Ethical
- Legal
- Methodological
- Any other aspect

Legend: ■ Yes ■ Uncertainty ■ No

| | Never | Once | Multiple | Regularly | Always |
|---|---|---|---|---|---|

(a) Personal acceptability

Legend (a): Unacceptable, Mostly unacceptable, Neither...nor..., Somewhat acceptable, Acceptable

Categories (a): Data fabrication, Data falsification, P-hacking, Plagiarism, Stealing of data, Stealing of ideas, Removing outliers*, Data manipulation*, Data manipulation in project proposal
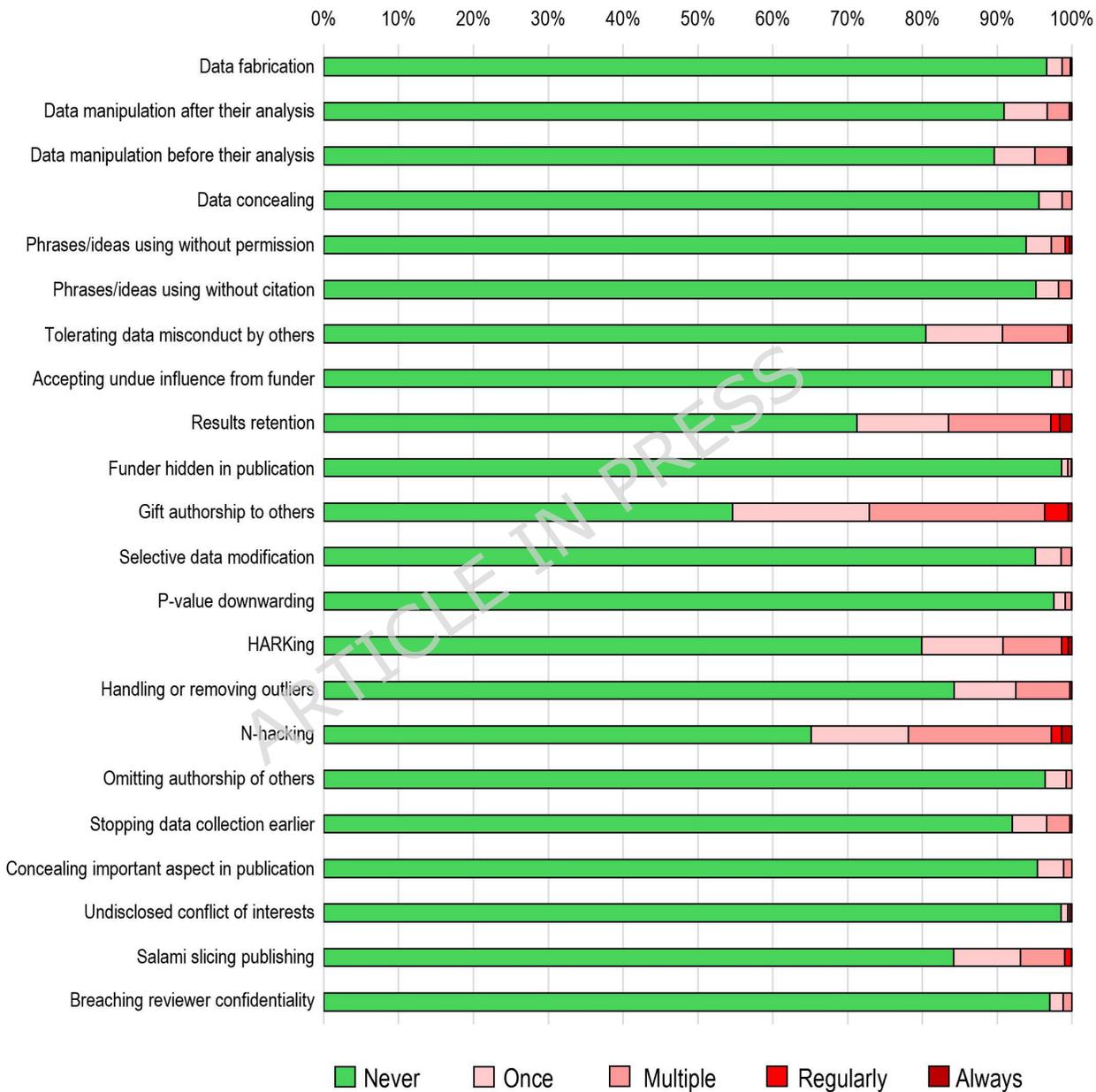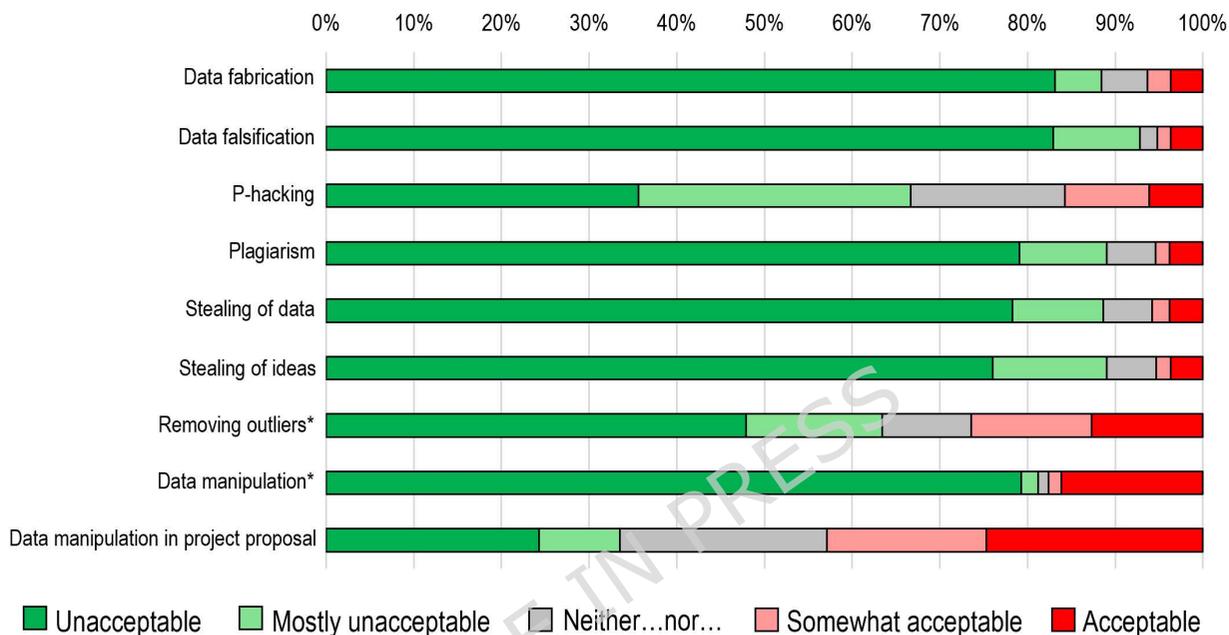
(b) Personal acceptability of whistleblowing and consequences

Categories (b): Whistleblowing of someone, Whistleblowing of co-worker or peer, Whistleblowing of supervisor or PI, Shared blame for fabricated data, Shared punishment for fabricated data

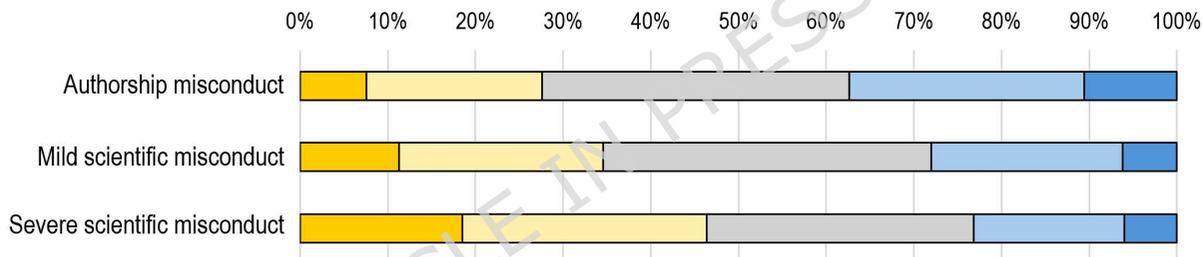Legend (b): Acceptable, Somewhat acceptable, Neither...nor..., Mostly unacceptable, Unacceptable
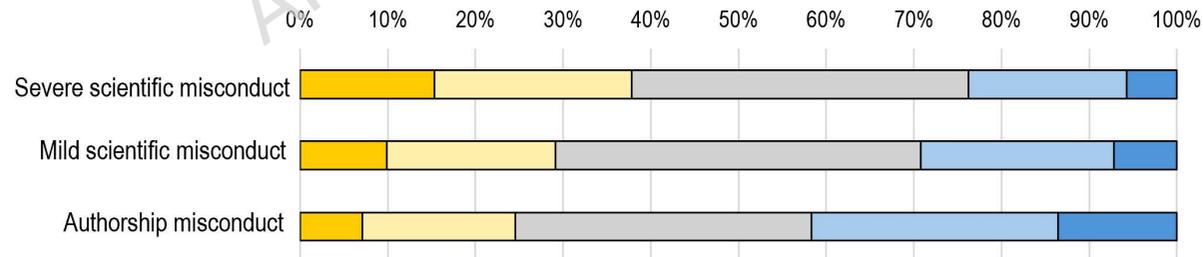
(a) Common occurrence
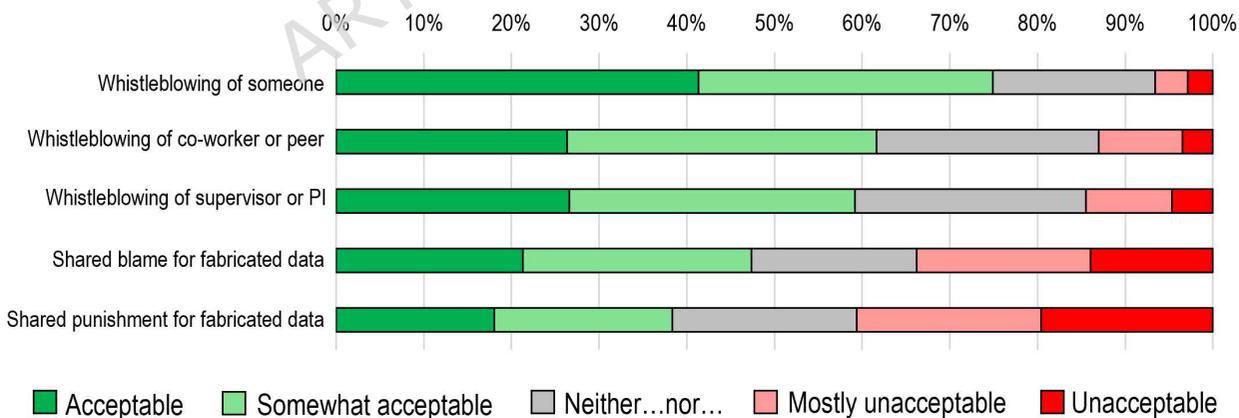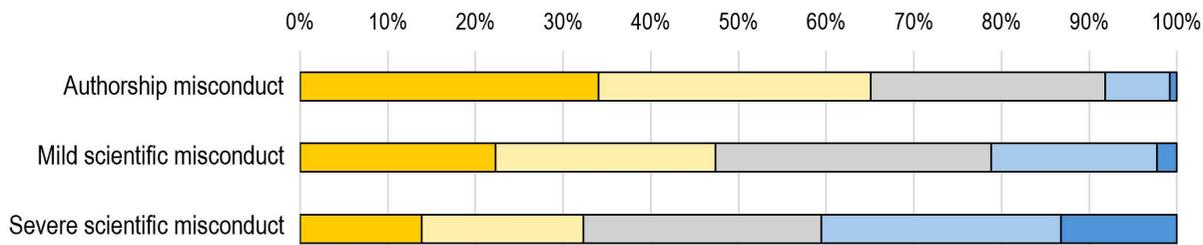
(b) High risk of misconduct detection

(c) Severe consequences of misconduct detection

Strong disagreement    Disagreement    Neither…nor…    Agreement    Strong agreement