Association between leadership commitment and professional development at NASA (2020): weighted sex-adjusted stratified analysis

DOCUMENT: SAR-2022-008-GJ-v01

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2022-02-02

TABLE OF CONTENTS

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Document version

Version	Alterations
01	Initial version

1 ABBREVIATIONS

- CI: confidence interval
- FEVS: Federal Employee Viewpoint Survey
- OPM: U.S. Office of Personnel Management
- OR: odds ratio

2 CONTEXT

The Federal Employee Viewpoint Survey (FEVS) addressed leadership commitment, professional development, and telework satisfaction while accounting for gender (OPM, 2020). This analysis addresses a subset of the FEVS survey reflecting NASA employees.

2.1 Objectives

Quantify the association between leadership commitment and employee professional development at NASA from the 2020 Federal Employee Viewpoint Survey.

2.2 Data reception and cleaning

Raw data was collected as a census of the eligible population (OPM, 2020), and statistical weighting was applied at the data collection to adjust for non-responses in in the census attempt. These survey weights (variable `postwt`) allow for the estimation of the association under study in the source population. The raw data was filtered to reflect only NASA survey respondents (where agency code equals `NN`).

The raw data is expected to reflect a total employee population at NASA at 16809 employees but after cleaning procedures the observations in the analytical data represents a total of 15283 NASA employees. Survey questions measured responses in a

5-point Likert scale between 1 (strongly disagree) and 5 (strongly agree). Some questions offered the option to choose "X" (Don't know) as the answer. These unknown answers were considered non-answers and treated as missing values.

All variables in the analytical set were labeled according to the raw data provided and values were labeled according to the data dictionary for the preparation of production-quality results tables and figures. This analysis will focus on two questions from the FEVS survey, where the main interest is employee satisfaction (q1 – I am given a real opportunity to improve my skills in my organization) as the dependent variable and leadership commitment (q21 – Supervisors in my work unit support employee development) as the independent variable. As per the data cleaning process, the dependent variable was renamed to `dv` and the independent variable was renamed to `iv` in the analytical dataset. Additionally, to calculate the OR the responses were categorized as binary responses, where agreement was aggregated from the "agree" and "strongly agree" responses, in variables `dv2` and `iv2`. After the cleaning process 7 variables were included in the analysis with 9633 observations.

3 METHODS

3.1 Variables

3.1.1 Primary and secondary outcomes

Primary outcome

Odds of participants that perceive opportunities of employee professional development at NASA from the 2020 Federal Employee Viewpoint Survey.

3.1.2 Covariates

The association will be stratified by the sex of survey respondents.

3.2 Statistical analyses

The epidemiological profile of the study participants will be described. Demographic (sex, age and BMI) will be described as mean (SD) or as counts and proportions (%), as appropriate. All comparisons between groups will be performed as univariate analyses. Differences in distribution of categorical variables will be assessed with the chi-square test with the adjustment of design effect for weighted survey data. The OR will be used as a measure of effect of the independent variable on the dependent variable. The stratification by sex will be used to assess if the effect changes across male and female strata. As a rule of thumb, a minimum change of 20% in the OR will be considered before concluding that there is an interaction between sex and the independent variable. The homogeneity of the OR across strata will be assessed with the Cochran-Mantel-Haenszel

test. All evaluations will be performed as complete case analyses. All analyses will be performed using the significance level of 5%. This analysis was performed using statistical software R version 4.1.2.

4 RESULTS

4.1 Study population and follow up

The sample evaluated in this study is comprised of 9633 observations representing 15283 NASA employees, out of a total of 16809. Two thirds of the study population are males (66.4%, Table 1).

Both survey questions addressed in this study showed most NASA employees demonstrated high levels of satisfaction when the survey was conducted. The proportion of employees that agree or strongly agree with the main outcome of this study (q1 – I am given a real opportunity to improve my skills in my organization) was 88.5%. The proportion of employees that agree or strongly agree with leadership commitment (q21 – Supervisors in my work unit support employee development) was 93.1%.

Table 1 *Characteristics of the study population. Each of the survey questions had 5 alternatives for answer: 1: strongly disagree, 2: disagree, 3: neither agree nor disagree, 4: agree, 5: strongly agree.*

Characteristic	N = 15,283
Sex	
Male	10,154 (66)
Female	5,129 (34)
I am given a real opportunity to improve my skills in my organization.	
1	183 (1.2)
2	477 (3.1)
3	1,104 (7.2)
4	6,137 (40)
5	7,382 (48)
Supervisors in my work unit support employee development.	
1	152 (1.0)
2	232 (1.5)
3	678 (4.4)

4	4,640 (30)
5	9,581 (63)

4.2 Association between leadership commitment and professional development

4.2.1 Overall association

In order to compare how the responses to the leadership commitment and employee development relate to each other, a cross-tabulation of all answers from each study participant is shown in Table 2. There is a detectable statistical difference in the distributions of the two responses (see section Observations), where the chi-square adjusted for survey design was significant.

This cross tabulation shows that the largest proportion of survey respondents answered 4 (agree) or 5 (strongly agree) to both questions. This means that there is a detectable association between leadership commitment and employee development. Considering this is a high-powered study, this could be due to statistical power alone, meaning that while a difference in proportions is detectable this analysis does not inform how large this difference is.

The effect size of this association will be reported in the next section.

Table 2 *Cross tabulation of survey responses.*

Characteristic	**Overall**, N = 15,283[1]	**I am given a real opportunity to improve my skills in my organization**,n (%)					**p-value**[2]
		1, N = 183[1]	**2**, N = 477[1]	**3**, N = 1,104[1]	**4**, N = 6,137[1]	**5**, N = 7,382[1]	
Supervisors in my work unit support employee development,n (%)							<0.001
1	152 (1.0)	81 (44)	45 (9.4)	10 (0.9)	11 (0.2)	5 (<0.1)	
2	232 (1.5)	39 (21)	97 (20)	46 (4.2)	42 (0.7)	8 (0.1)	
3	678 (4.4)	21 (11)	119 (25)	264 (24)	238 (3.9)	37 (0.5)	
4	4,640 (30)	15 (8.1)	161 (34)	534 (48)	3,127 (51)	803 (11)	
5	9,581 (63)	27 (15)	56 (12)	250 (23)	2,719 (44)	6,529 (88)	

[1]n (%) [2]chi-squared test adjusted by a design effect estimate

4.2.2 Stratification by sex

In order to estimate the size of the effect of the association a binary categorization was performed between the two survey responses, where agreement aggregates all answers 4 (agree) and 5 (strongly agree). Table 3 shows the contingency table that cross-tabulates these variables. There is a detectable statistical difference in the distributions of the two responses (see section Observations), where the chi-square adjusted for survey design was significant.

The effect of the association was significant (OR: 26.81, 95% CI: [23.25, 30.96]). This means that when survey respondents perceive leadership commitment, they are 27 times as likely to report employee development as participants that do not perceive such commitment from leadership. Alternatively this translates to a 26-fold increase in the group of interest when compared to the reference group.

Table 3 *Cross tabulation of dichotomized responses, overall and by sex of survey respondents.*

Characteristic	**I am given a real opportunity to improve my skills in my organization**								
	Overall			Males			Females		
	No Agree, N = 1,764[1]	**Agree**, N = 13,519[1]	**p-value**[2]	**No Agree**, N = 1,180[1]	**Agree**, N = 8,974[1]	**p-value**[2]	**No Agree**, N = 584[1]	**Agree**, N = 4,545[1]	**p-value**[2]
Supervisors in my work unit support employee development.			<0.001			<0.001			<0.001
No Agree	722 (41%)	340 (2.5%)		461 (39%)	206 (2.3%)		260 (45%)	134 (3.0%)	
Agree	1,043 (59%)	13,179 (97%)		719 (61%)	8,768 (98%)		324 (55%)	4,411 (97%)	

[1]n (%) [2]chi-squared test adjusted by a design effect estimate

In order to control for a possible interaction between the association and the sex of the study participant, the analysis was replicated for each sex. In both cases the chi-square test was significant (see section Observations), meaning that a possible interaction is detectable, and this possibility is confirmed by the Cochran-Mantel-Haenszel test (p<0.001).

The effect sizes for males and females were similar to each other (OR: 27.26, 95% CI: [22.78, 32.70] and females: OR: 26.36, 95% CI: [20.84, 33.51]). These effect sizes do not

fall in the rule of thumb of accepting a difference in the OR of up to 0.2 as similar so after controlling for sex, the association is affected by sex.

This means that, when they perceive leadership commitment, men appear to show higher levels of employee development than women, when compared to the reference group.

Although the difference in the overall OR and the sex-stratified ORs is larger than 1, it can be noted that the relative difference between these ORs is very small (relative difference for males: 1.7%, relative difference for females -1.7%). Although this interaction cannot be discarded, it may not be a true interaction. One possible explanation for this is the very large magnitude of the effect size (OR circa 27, both overall and in all strata), so the actual difference is larger than the pre-specified (absolute) threshold, but when considering the scale of the measures, the difference may not be perceived as large. Since there is effect modification, it is recommended that when reporting these results, both stratified OR also be reported, instead of the overall OR alone.

The additional analysis in the next section might shed light on this issue.

4.2.2.1 Additional analyses

In order to assess the possibility that sex is a confounder, the association between sex and the dichotomized responses for both leadership commitment and employee development were evaluated. The proportion of participants that perceive high levels of leadership commitment does not vary by sex (p=0.402). Additionally, the proportion of participants that perceive employee development do not vary by sex (p=0.195).

Sex is not associated with either leadership commitment or employee satisfaction. This means that sex is not confounding the overall association of this analysis.

5 OBSERVATIONS AND LIMITATIONS

After accounting for the complex design of the survey that acquired the raw data used in this report, the analysis effectively simulates a census of the NASA employees perception of the workplace culture. This large sample provides high levels of statistical power to detect even small differences in proportions. This is the reason that most p-values can be reasonably expected to be significant in this sample.

On the other hand when considering the measure of effect of the associations evaluated here, this large power becomes an asset since it provides a high precision in the estimation of effects, meaning all confidence intervals are narrow and we have more confidence in the estimates provided. Since these are the main results to report, in this analysis the high power is welcome.

6 CONCLUSIONS

There is a positive association between leadership commitment and employee development where employees that perceive high levels of commitment they also perceive 27 times as much opportunities for development when compared with employees that do not perceive high leadership commitment.

Although these proportions appear to vary by sex, males had a higher perception of development opportunities when compared to females.

7 REFERENCES

- **SAP-2022-008-GJ-v02** – Analytical Plan for Association between leadership commitment and professional development at NASA (2020): weighted sex-adjusted stratified analysis
- OPM (2020). 2020 Federal Employee Viewpoint Survey – Technical report (https://www.opm.gov/fevs/reports/technical-reports/).

8 APPENDIX

8.1 Exploratory data analysis

8.2 Availability

Both this document and the corresponding analytical plan (**SAP-2022-008-GJ-v02**) can be downloaded in the following address:

https://philsf-biostat.github.io/SAR-2022-008-GJ/

8.3 Analytical dataset

Due to confidentiality the data-set used in this analysis cannot be shared online in the public version of this report.

Table A1 *Analytical dataset structure*

id	dsex	dv	iv	dv2	iv2	postwt
1						
2						
3						
…						

9633						