Decomposing the association between the amount of exposure and the frequency of self-reported involvement in a road crash

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ABSTRACT
We tried to obtain preliminary evidence to test the hypothesis that the association between driving exposure and the frequency of reporting a road crash can be decomposed into two paths: direct and indirect (mediated by risky driving patterns). In a cross-sectional study carried out between 2007 and 2010, a sample of 1114 car drivers who were students at the University of Granada completed a questionnaire with items about driving exposure during the previous year, risk-related driving circumstances and involvement in road crashes. We applied the decomposition procedure proposed by Buis for logit models. The indirect path showed a strong dose-response relationship with the frequency of reporting a road crash, whereas the direct path did not. The decomposition procedure was able to identify the indirect path as the main explanatory mechanism for the association between exposure and the frequency of reporting a road crash.

INTRODUCTION
Causal associations between exposures and outcomes may be direct or indirect (ie, mediated through the effect of intermediate variables). For instance, it can be hypothesised that the well-known relationship between the amount of exposure as a car driver and the risk of involvement in a road crash1–3 can be broken down into direct and indirect paths (figure 1). In the former, the amount of exposure leads to a higher risk of involvement in a crash as a result of increasing time at risk. In the latter, the link between exposure and road crashes is mediated by an increase in the frequency of well known risky driving patterns.4–6 This path implies that an increase in exposure leads to a higher frequency of involvement in circumstances, such as driving at night or at higher speed. Previous studies support this relationship.4 7 8

We found no previous studies designed to test the above hypothesis, and therefore, tried to obtain preliminary empirical evidence to support or refute it. We applied the analytic approach recently proposed by Buis,9 (an extension of the decomposition method developed by Eriksson et al10 for logit models) to a cross-sectional study of university students that explored driving exposure as car drivers (km/year driven), the involvement in risky driving patterns and the frequency of reporting a road crash. Our aim was to decompose the association between the amount of exposure and the frequency of reporting a road crash in a direct path and in an indirect path (mediated through risky driving patterns).

MATERIALS AND METHODS
The eligible population for this cross-sectional study comprised all students enrolled in any of the courses offered by the department of preventive medicine and public health at the University of Granada (southern Spain) during the academic years 2007/2008, 2008/2009 and 2009/2010, and who attended classes during at least the first 2 weeks of any given course. After informing them about the study aims, the course instructors asked all students to complete a brief self-administered questionnaire. A total of 1114 students who completed the questionnaire and who stated they had driven a passenger car during the previous year comprised our final sample.

The questionnaire (shown in the web Appendix) was developed by an expert panel after an extensive review of previous instruments.11 Among other variables, it explored driving exposure (km/year driven in the previous year) originally stratified in eight categories (<500 km, 500–999, 1000–4999, 5000–9999, 10 000–19 999, 20 000–29 999, 30 000–50 000, >50 000) and finally categorised in four strata (<500 km/year, 500–999, 1000–4999 and >5000), driving patterns measured as involvement or not during the preceding month in 22 driving circumstances potentially related with the risk of involvement in a road crash (see the web Appendix for a detailed description of each circumstance) and involvement in a road crash that did or did not result in injuries during the previous year. All these circumstances have been associated with varying degrees with an increased risk of having an accident, according to earlier research.11

Analysis: We used the method proposed by Buis,9 a generalisation of the original decomposition method developed by Eriksson et al.10 This method decomposes the total association between a categorical, discrete or continuous exposure variable, and an outcome in a direct effect and an indirect effect. In our case, we applied the Buis procedure to a logit model in which the outcome was the log (odds) of reporting involvement in a road crash during the previous year, exposure was the number of kilometres driven in the previous year (stratified in four levels), and the intermediate variable was the number of driving circumstances reported by each driver, included in the model as a continuous variable. The model also included sex, age and years in possession of...
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Table 1 Total, Direct and indirect associations between the amount of exposure and reported involvement in a road crash among students at the University of Granada, Spain, 2007–2010

| Exposure (Reference: <500 km/year) | Total | Direct | Indirect (mediated through risky driving patterns) |
|-----------------------------------|-------|--------|-------------------------------------------------|
|                                   | OR    | 95% CI | OR     | 95% CI | % of the total association* | OR     | 95% CI | % of the total association* |
|-----------------------------------|-------|--------|--------|--------|--------------------------|--------|--------|--------------------------|
| 500–999 km/year                   | 0.70  | 0.17 to 2.82 | 0.50  | 0.12 to 2.02 | 191.64 | 1.39  | 1.10 to 1.75 | 91.64 |
| 1000–4999 km/year                 | 3.74  | 1.43 to 9.77 | 2.11  | 0.77 to 5.81 | 56.52  | 1.78  | 1.22 to 2.58 | 43.48 |
| ≥5000 km/year                     | 4.14  | 1.59 to 10.83 | 1.76  | 0.60 to 5.21 | 39.87  | 2.35  | 1.40 to 3.95 | 60.13 |

*These columns report the proportion of the association attributable to the direct and indirect paths assuming a value of 100% for the total association.
5.0%. For a given column, the indirect association shows a clear dose-response relationship for increasing exposure level, whereas this is not the case for the direct associations (rows): the counterfactual frequencies of reporting a road crash are lowest for the second exposure level, and highest for the third level.

**DISCUSSION**

Regarding our initial hypothesis that two different paths can be identified to relate the amount of exposure to the frequency of reporting a road crash, our results suggest that the relationship mediated through the association between exposure and involvement in risky driving patterns is clearly more important than the relationship mediated simply through the increase in time at risk. Although many studies have reported the crude and adjusted associations between the risk of a road crash and the amount of exposure, or certain driving patterns, no previous studies have applied an appropriate decomposition method to test this hypothesis. Our results suggest that the relationship mediated through the association between exposure and involvement in risky driving patterns is clearly more important than the relationship mediated simply through the increase in time at risk.

Our study should be viewed as an initial attempt to shed light on our decomposition hypothesis. Its cross-sectional nature makes it impossible to demonstrate causal associations between the variables explored here. In fact, inverse causality cannot be ruled out because the period in which risky driving circumstances were explored comprised only the month prior to the interview, whereas exposure and road crashes were explored for the previous year. Our results may also be affected by information bias: although the questionnaire used to explore driving patterns has acceptable convergent and criterion validity, this source of bias cannot be ruled out entirely. Furthermore, we used a rather simple index to measure the indirect effect, and did not consider the different roles of each specific risk-related circumstance. Regarding external validity, our results were obtained for a population of mainly young, inexperienced and predominantly female drivers—a demographic composition typical among students in health sciences degree programmes at Spanish universities. There is no reason to suspect that the associations found in this population would differ greatly in other subgroups of drivers, and all our estimates were adjusted by gender, age and years in possession of a driving license (a correlate of experience). These caveats, notwithstanding, the Buis procedure allows the inclusion of other adjusting variables not considered in the present study, such as variables for driving inexperience. Further studies in other populations will, therefore, be needed to confirm the consistency of our results. In addition, the same analytical approach as we used here should be applied to data from cohorts of drivers.

**What this study adds**

- Although many studies have reported the crude and adjusted associations between the risk of a road crash and the amount of exposure or certain driving patterns, no previous studies have applied an appropriate decomposition method to test this hypothesis. Our results suggest that the relationship mediated through the association between exposure and involvement in risky driving patterns is clearly more important than the relationship mediated simply through the increase in time at risk.

**Key points**

- The relationship between the amount of exposure as a car driver, and the risk of involvement in a road crash is well known.
- The association between driving exposure, and the frequency of reporting a road crash, can be decomposed into two paths: direct and indirect (mediated by risky driving patterns).
- The relationship mediated through the association between exposure and involvement in risky driving patterns is clearly more important than the relationship mediated simply through the increase in time at risk.

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### Texting while driving linked with other risky behaviours

A recent study by CDC shows that texting while driving among US high school students is linked with drinking and driving, or riding with someone who has been drinking. This study in paediatrics is hardly surprising but worth emphasising. Of special importance is the key finding that nearly half of them text or email while driving, and those who do so are nearly twice as likely to drink and drive, and five times as likely to drink and drive, than students who do not text while driving. Most states have laws to limit texting or cell phone use while driving, but there are few evaluations of these laws and, thus, no evidence that the laws reduce crashes. The CDC release emphasises the role parents can have in curtailting these dangerous behaviours.

### CAPT child safety week focuses on poisoning

A popular approach to poison prevention in the UK (and, I assume, much of Europe) was the focus of this year’s Child Safety Week sponsored by Child Accident Prevention Trust (CAPT). To drive home to parents the dangers of childhood poisoning, and the risks lurking under their kitchen sinks, CAPT advocated that parents taste Bitrex the most bitter substance on Earth. (I use it to discourage squirrels from eating my garbage and I can testify to how bitter it is!) To combat poisoning, Bitrex is added to household products that young children might drink. It acts as a third line of defence against poisoning (after storing products out of reach and child-resistant packaging). CAPT suggests you see for yourself by checking out a Youtube video of parents taking the Big Taste test.

http://www.youtube.com/watch?v=4kugKYHZQTU

http://www.fairtrading.qld.gov.au/consumer-product-related-injuries-in-Qld-children.htm