Accuracy of comparing bone quality to chocolate bars for patient information purposes: observational study

Phil Jones, Sarah Jones, Debbie Stone

ABSTRACT
Objective To test whether standard information for patients using Crunchie and Aero chocolate bars to explain bone health and risk of fracture is robust.
Design Observational study.
Setting Domestic kitchen in rural west Wales.
Participants 10 Crunchie bars and 10 Aero bars.
Main outcome measure Fracture after falls from varying heights.
Results Both Crunchie and Aero bars exhibited the same T and Z scores for bone density. Crunchie bars had a lower chocolate mass index than the Aero bars. Crunchie bars are more liable to fracture.
Conclusions Using Crunchie and Aero chocolate bars to explain bone structure to patients may be visually attractive but oversimplifies the situation.

INTRODUCTION
It is important that information provided to patients as part of their treatment should be comprehensive and accurate. Within our area of practice relating to osteoporosis and fragility fracture we have noticed a tendency to compare normal, healthy bone to the finely honeycombed structure of a Crunchie (Cadbury Trebor Bassett; Bournville, Birmingham) chocolate bar and to compare abnormal, osteoporotic bone to the coarser structure of an Aero (Nestle UK; York) bar (fig 1). Although this explanation is readily appreciated by patients and clinicians it struck us that the comparison may not be completely valid as no work has been published on the fracture potential of each bar. This might mean that with best intentions we are advising patients to aspire to a bone structure that is actually more liable to fracture. To enable us to provide accurate data to our patients we studied the fracture risk for each chocolate bar.

METHODS
We randomly purchased 20 chocolate bars (10 Crunchie and 10 Aero) from a reputable high street confectioner; the number of bars was limited by research funds and our rural environment. Each bar was measured to provide information on height (defined as the longest dimension of the bar, in metres) and mass (determined in kilograms). The composition of the bar was determined through reference to the packaging. We could ascertain no data on other fracture risks. The tests were completed in a controlled environment and the flooring was standard 33×33 cm ceramic kitchen floor tiles with average grouting. This environment was chosen as being representative of the home environment, where many fractures occur.

The end point of the study was fracture. Firstly, we allowed each bar to topple from its standing height in the centre of a tile. We then dropped each bar horizontally on to the centre of the tile from increasing heights until fracture, defined as a break in the cortex;
we did not regard mild deformity as a fracture. The tests were carried out at a temperature of 22°C after the bars had had eight hours to reach a steady state temperature. We used a bone densitometer (Discovery-C; Hologic, Bedford, MA) to carry out dual energy x ray absorptiometry (whole body) on one Aero and one Crunchie, with bone mineral density being used as a surrogate for measuring chocolate density. Height was measured with a tape measure (Olympia (5 m/16 ft) Power Return Tape; Olympia (UK); Reading, Berks). We chose a Kaplan-Meier “fracture free” survival curve as the best means of analysing the data obtained.

RESULTS
The table provides comparative data for Crunchie and Aero chocolate bars. All bars had the same dimensions (to within the accuracy of our measure). No bars fractured in falls from a standing height. A Kaplan-Meier survival curve shows the occurrence of fractures according to heights (fig 2). Figures 3-5 show the range of fractures.

DISCUSSION
Using Crunchie and Aero chocolate bars to explain bone structure and fracture risk to patients may be visually attractive but oversimplifies the situation. Our findings must be interpreted with some caution as we used a small number of participants and the falls were not low trauma—that is, standing height or less. To date a reliable population database for chocolate densities has not been established and we acknowledge that our reference population is somewhat subjective; there may be scope for further research in this area, including risk of fracture over 10 years. Our findings, however, clearly show that despite the apparently more robust structure of a Crunchie it is more likely to fracture than an Aero.

It is generally recognised that bone strength is a reflection of bone density and bone quality and therefore the explanation for our incidence of fracture is likely to be multifactorial. It may include differences in chocolate mass index (2.16 for Crunchie v 2.76 for Aero), and the higher protein content of the Aero is likely to provide more elastic stress properties than that of the Crunchie.

Fig 2 Fracture free survival curves for Crunchie and Aero chocolate bars

Fig 3 Simple, complete fracture at interchunkal area of Aero chocolate bar, the only fracture seen in the Aero group

Fig 4 Splinter fracture in Crunchie chocolate bar

Fig 5 "Blow-out" fracture at higher fall heights in Crunchie chocolate bar

Characteristics of Crunchie and Aero chocolate bars

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Crunchie</th>
<th>Aero</th>
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</thead>
<tbody>
<tr>
<td>Height (m)</td>
<td>0.136</td>
<td>0.129</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>0.04</td>
<td>0.046</td>
</tr>
<tr>
<td>Chocolate mass index (kg/m2)</td>
<td>2.16</td>
<td>2.76</td>
</tr>
<tr>
<td>Content:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein (g)</td>
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<td>Carbohydrate (g)</td>
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<td>Fat (g)</td>
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<tr>
<td>Fibre (g)</td>
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<td>Sodium (g)</td>
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<tr>
<td>Calcium (g)</td>
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<tr>
<td>Collagen (g)</td>
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<td>No data</td>
</tr>
<tr>
<td>T score†</td>
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<td>−8.8</td>
</tr>
<tr>
<td>Z score‡</td>
<td>−9.5</td>
<td>−8.8</td>
</tr>
</tbody>
</table>

† and ‡ scores are referenced to 50 year old woman.

†Number of standard deviations above (or below) mean for peak bone mineral density score.
‡Age and sex matched number of standard deviations above (or below) the mean bone mineral density score.
Our data provide evidence of the disparity between chocolate density and fracture rates. The use of Crunchie and Aero bars to explain bone health and fracture risk to patients, although palatable, is not justified. In practical terms we believe that the findings should contribute to the provision of improved patient information and education by enlightened healthcare professionals. The study serves to remind clinicians that both chocolate density and bone mineral density form but one component of fracture risk. The accurate assessment of fracture risk should ideally take into account other measurable indices that contribute to fracture risk in addition to that provided by chocolate density and bone mineral density.

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Contributors: PJ, SJ, and DS recognised the need for research in this area and devised the protocol. DS recorded the data. PJ and SJ carried out the drop tests. PJ, DS, and SJ wrote the manuscript. PJ is guarantor.

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