# **Supplementary Information**

## Sample Characteristics

We recognize that sample sizes are small for certain times and places and point out cases where additional data may lead to changed interpretations. We also recognize that the spatial coverage for each period is uneven, that a variety of taphonomic/formation processes might make sites whose occupations ended in violence more likely to be excavated, and that the excavated contexts from which we derive our indices are not probabilistic samples of the settlement system in any region or period. We acknowledge that other analysts might make different decisions about what types of trauma to include or exclude in summary measures such as our conflict index (W). For example, some small percent of what we call cranial trauma is probably not due to interpersonal violence. Finally, we recognize that any sample derived from the literature, as ours is here, will contain some errors and will reflect variable biases and training of the original analysts. It seems far better to us to tolerate these sources of "noise" than to simply ignore these unique and literally irreplaceable samples. Our hope is that all these factors, which clearly matter at a finer scale of analysis, essentially come out in the wash when one summarizes a large volume of archaeological research at the scales of regions and centuries. In short, we assume our sample is reasonably representative, even though we know that it is not comprehensive. Further research, and archaeological source criticism in the several senses developed by Kristiansen (1978), should improve upon the reading of the record of violence in the Pueblo past that we develop here.

# Conflict Index

Debate over the presence of conflict in the prehispanic Southwest is bound up with the definitions used to categorize violence. Here we develop an index of violence based on trauma to human bone, trying to exclude trauma due to accidental injury to the extent possible. The trauma we track may be due to any combination of warfare ("organized, purposeful group action, directed against another group that may or may not be organized for similar action, involving the actual or potential application of lethal force" [Ferguson 1984:5]), raids, ambushes, massacres, violent resistance, feuding, and intracommunity and possibly ritualized violence such as the execution of suspected witches (Palkovich 2012 discusses a possible example for the NRG).<sup>1</sup> Presumably much but certainly not all of this violence was in fact between independent communities or polities.

We do not believe the trauma preserved on human bone can always be assigned unambiguously to some specific source such as interpersonal violence vs. intergroup hostility, though Arkush and Tung (2013:Table 2) note some general tendencies. These authors also argue that inter- and intragroup violence tend to be strongly correlated in any case, and Ember et al. (1992) demonstrate cross-cultural correlations between war and other forms of violence. For this reason we consider our index of trauma to be an index of *both* interpersonal violence and warfare; we will generally use the terms "conflict" and "violence" interchangeably. We consider the term "conflict" to be slightly more fundamental, since violence (including domestic or ritualized violence) stems from conflict in every case we can imagine. It is worth keeping in mind however that violence and conflict are secondary inferences derived from what can be directly observed on the bones, which is trauma.

Fractures to the radius or ulna most likely result from a blow to an arm raised in defense and are commonly attributed to intergroup conflict (Judd 2008). These are often referred to generally

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as "parry fractures," though Judd argues that four criteria must be met in order to properly identify such a fracture. We followed her guidelines to the extent possible, though available site reports and gray literature do not always contain the needed detail.<sup>2</sup> We acknowledge that such injuries can sometimes be sustained by blocking a fall.

Cranial fractures are also complicated, as they may result from accidental falls in the elderly or in children; here we consider only nonfacial cranial fractures to be conflict related. Intentional and systematic dismemberment and breakage of bone, often referred to as "extreme processing," is also coded as violence, following criteria developed by Turner and Turner (1999:24) and also employed by Kuckelman et al. (2000, 2002). Skeletal remains must be complete enough to reliably determine the presence or absence of violence. We would not code trauma as either present or absent for any individual unless we had at least a cranium and a radius or ulna represented. Contextual evidence of violence reported by excavators, such as informal or haphazard deposits of bodies, could be used to alter these coding rules where that seemed sensible. In general, we consider the decisions we made in coding trauma as violence to be conservative. All information was obtained from library research, including as much gray literature as we could access. In many cases the remains from which our data derive have been repatriated and are no longer available for study.

Using these data, we define *W* as the proportion of sets of human remains exhibiting trauma as defined above for each period in each region. Given appropriate conditions of preservation and sample size, we think this index is the best *single* indicator of the relative frequency of conflict available to us in the archaeological record. But it is of course imperfect. People can suffer much violence that is not osteologically visible. Likewise, architecture, site placement, and several other possible indicators of conflict enrich our understanding of the type and level of

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violence. We offer the line of research developed here as a step towards systematizing the archaeological record of violence to allow interregional comparisons, not as an attempt to channel all future discussion of violence in the archaeological record of the Southwest.

#### Population Size and Paleoproduction

Our methods for obtaining the momentary population size estimates through time for the CMV region are presented by Ortman et al. (2007) and by Varien et al. (2007). Population estimates for the NRG are drawn from Ortman (2012:77-78) and were generated as described there (Ortman 2012:57–86). We emphasize variability in maize production in this paper, rather than climate variability per se, since we strongly agree with Harrod and Martin (2014) that the relationship between climate variability and violence needs to be examined through the lens of those aspects of environmental variability that directly affect people. Derivation of potential maize production estimates for the CMV is explained in Kohler (2012) and the series is graphed in Varien et al. (2007:Figure 3). As these references explain, our production estimates begin from the same Mesa Verde Douglas fir ring-width index series graphed by Dean and Van West (2002, Figures 4.1–4.3) but also employ a paleotemperature record derived from bristlecone pine ring-width index series, soil characteristics, and historic-period maize production to estimate potential maize productivity in prehistory. The tree-ring records provide *climate* series that are turned into a productivity series by this additional work. Production estimates (means and standard deviations) are then derived from this production series for the periods we can recognize archaeologically, rather than for climatically distinct periods, as done by Dean and Van West.

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Paleoproduction estimates derived from similar methods have not yet been developed for the NRG, so we have developed a preliminary series here, building from the assumption that the most important variable affecting maize production in the NRG is precipitation. We extracted the first principal component from three new tree-ring-derived precipitation reconstructions (Arroyo Hondo, Jemez, and Chama) that spatially bracket our NRG study area and are reported in Towner and Salzer (2013). We used this signal to create a first-order estimate of what the potential maize production in the NRG might have been if dry farming (rain-fed farming) dominated their production systems. The resultant estimates have the same mean and standard deviation as the CMV production series.

Of course, even though maize constituted some 80 percent of Basketmaker and Pueblo diets (Coltrain et al. 2006), other resources were important. Models exist for estimating the productivity of some of these other resources in the CMV (e.g., Johnson and Kohler 2012), but we do not yet have comparable models for the NRG. However, precipitation is a main factor in maize production in the CMV model, and the only factor in the provisional NRG model, and one would expect it to have an effect on all resources in these semiarid environments. So there is some basis for suggesting that our maize production models can serve as proxies for overall net primary productivity in our study areas.

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#### Notes

1. This example also illustrates some of the problems with studying the bioarchaeology of violence in the ancient Southwest based on the literature. In her authoritative 1980 monograph on the human remains from Arroyo Hondo, Palkovich noted two instances of violence (a projectile wound, and some broken teeth) among the 120 burials analyzed. But Palkovich (2012:12) mentions 12 individuals from Arroyo Hondo subjected to "acts of violence or post-mortem manipulation." Here we have used the data in the original monograph, since we could not judge the completeness of the remains or the component to which they belonged from the more recent publication. We likewise encountered disagreements in inferred violence when the same skeletal remains were analyzed by more than one researcher.

2. If the reports or literature did not contain enough detail on individuals to determine the presence/absence of trauma to the radius or ulna, and the cranium, the individual was removed from the sample. For example, we removed seven individuals from the Te'ewi sample due to the fragmentary nature of the remains.

| Period | Dates<br>(A.D.) | Period Name            | Sites   | References                                   | x (total<br>with<br>conflict-<br>related<br>trauma) | Total <i>n</i><br>human<br>remains |
|--------|-----------------|------------------------|---|--|---|------------------------------------|
| 1      | 800–<br>1050    | Early<br>Developmental | Nogales Cliff<br>House (LA 649)               | Dick 1976                                    | 8   | 16                                 |
|        |                 |                        | Pena Blanca (LA<br>265)                       | Akins et al. 2010                            | 2   | 6                                  |
|        |                 |                        | Pena Blanca (LA<br>6169)                      | Akins et al. 2010                            | 2   | 7                                  |
|        |                 |                        | Pena Blanca (LA<br>6171)                      | Akins et al. 2010                            | 1   | 2                                  |
|        |                 |                        | Pena Blanca (LA<br>115862)                    | Akins et al. 2010                            | 0   | 4                                  |
|        |                 |                        | LA 103919                                     | Akins et al. 2010                            | 3   | 6                                  |
| 2      | 1050–<br>1200   | Late<br>Developmental  | North Bank Site<br>(LA 6462)                  | Lange 1968                                   | 1   | 13                                 |
|        |                 |                        | Taos Composite<br>Valdez (TA 1 + 5<br>others) | Whitley 2009                                 | 12  | 36                                 |
|        |                 |                        | Pena Blanca (LA<br>249)                       | Akins et al. 2010                            | 1   | 1                                  |
|        |                 |                        | Pena Blanca (LA<br>6169)                      | Akins et al. 2010                            | 2   | 3                                  |
|        |                 |                        | LA 11850                                      | Seaman 1976                                  | 1   | 4                                  |
|        |                 |                        | Kinslow (LA<br>11843)                         | Seaman 1976                                  | 0   | 2                                  |
|        |                 |                        | LA 11841                                      | Seaman 1976                                  | 1   | 1                                  |
|        |                 |                        | Pojoaque (LA 391)                             | Akins p.c. 2013                              | 2   | 6                                  |
|        |                 |                        | LA 103919                                     | Akins p.c. 2013                              | 2   | 6                                  |
| 3      | 1200–<br>1275   | Early Coalition        | Tijeras Pueblo                                | Ferguson 1977;<br>Judge 1974;<br>Rhine 1974: | 4   | 40                                 |

| Supplementary | 7 Table 1 | 1. Sites Used | to Estimate I | Proportions | of Human | Remains wi | ith Trauma, | Northern Rio | Grande. |
|---------------|-----------|---------------|---------------|-------------|----------|------------|-------------|--------------|---------|
|               |           |               |               |             |          |            |             |              |         |

## Williams 2005

|   |               |                                       | Pecos Pueblo B/w<br>(LA 53684)       | Hooton 1930               | 2  | 15  |
|---|---------------|---------------------------------------|--------------------------------------|---------------------------|----|-----|
|   |               |                                       | Pena Blanca (LA<br>265)              | Akins et al. 2010         | 0  | 1   |
|   |               |                                       | Pena Blanca (LA<br>6169)             | Akins et al. 2010         | 2  | 3   |
|   |               |                                       | El Pueblo de Santa<br>Fe (LA 1051)   | Lentz 2011                | 2  | 15  |
|   |               |                                       | Burnt Mesa (LA<br>60372)             | Niskanen 1989             | 0  | 1   |
| 4 | 1275–<br>1350 | Late<br>Coalition/Earliest<br>Classic | Pot Creek Pueblo<br>(TA 1)           | Whitley 2009              | 5  | 60  |
|   |               |                                       | Arroyo Hondo (LA<br>12 Comp. I)      | Palkovich 1980            | 2  | 104 |
|   |               |                                       | Pecos Pueblo (LA<br>53684 B/w or I)  | Hooton 1930               | 1  | 4   |
|   |               |                                       | San Cristóbal (LA<br>80)             | Stodder 1990              | 3  | 49  |
| 5 | 1350–<br>1400 | Early Classic                         | Arroyo Hondo (LA<br>12 Comp. II)     | Palkovich 1980            | 0  | 11  |
|   |               |                                       | Pecos Pueblo (LA<br>53684 Glaze I)   | Hooton 1930               | 4  | 22  |
| 6 | 1400–<br>1450 | Middle Classic                        | Alfred Herrera (LA<br>6455)          | Lange 1968                | 5  | 62  |
|   |               |                                       | Te'ewi (LA 581)                      | Reed 1953;<br>Turner 1999 | 12 | 21  |
|   |               |                                       | Pecos Pueblo (LA<br>53684 Glaze II)  | Hooton 1930               | 2  | 14  |
|   |               |                                       | El Pueblo de Santa<br>Fe (LA 1051)   | Lentz 2011                | 0  | 10  |
| 7 | 1450–<br>1500 | Late Classic                          | Pecos Pueblo (LA<br>53684 Glaze III) | Hooton 1930               | 2  | 31  |
|   |               |                                       | Pecos Pueblo (LA                     | Hooton 1930               | 3  | 14  |

|    |               |                        | 53684 indet. date)                  |              |   |     |
|----|---------------|------------------------|-------------------------------------|--------------|---|-----|
|    |               |                        | San Cristóbal (LA<br>80)            | Stodder 1990 | 3 | 79  |
| 8  | 1500–<br>1540 | Terminal Classic       | Pecos Pueblo (LA<br>53684 Glaze IV) | Hooton 1930  | 2 | 30  |
| 9  | 1540–<br>1680 | Contact &<br>Colonial  | San Cristóbal (LA<br>80)            | Stodder 1990 | 1 | 130 |
|    |               |                        | Pecos Pueblo (LA<br>53684 Glaze V)  | Hooton 1930  | 7 | 20  |
| 10 | 1680–<br>1760 | Revolt &<br>Reconquest | Pecos Pueblo (LA<br>53684 Glaze VI) | Hooton 1930  | 2 | 13  |

| VEP<br>Period | Dates (A.D.)  | Pecos period               | Mean                    | x (total  | Total <i>n</i> | Raw   | Final                     | Average                 |
|---------------|---------------|----------------------------|-------------------------|-----------|----------------|-------|---------------------------|-------------------------|
|               | ( )           |                            | momentary               | with      | human          | W     | $\mathrm{W}^{\mathrm{b}}$ | per capita              |
|               |               |                            | population <sup>a</sup> | conflict- | remains        | (x/n) |                           | potential               |
|               |               |                            |                         | related   |                |       |                           | maize                   |
|               |               |                            |                         | trauma)   |                |       |                           | production <sup>c</sup> |
| (             | (00           | T . 4 .                    |                         |           |                |       |                           |                         |
| 6             | 600–<br>725   | Late<br>Basketmaker<br>III | 1,826                   | 2         | 11             | .182  | .104                      | 1.5898                  |
| 7             | 725–<br>800   | Early Pueblo<br>I          | 1,955                   | 1         | 10             | .100  | .000                      | 1.314                   |
| 8             | 800–<br>840   | Mid-Pueblo<br>I            | 5,013                   | 0         | 6              | .000  | .000                      | 187                     |
| 9             | 840–<br>880   | Late Pueblo<br>I           | 6,181                   | 3         | 55             | .055  | .036                      | 403                     |
| 10            | 880–<br>920   | Terminal<br>Pueblo I       | 2,223                   | 6         | 18             | .333  | .315                      | .952                    |
| 11            | 920–<br>980   | Incipient<br>Pueblo II     | 1,733                   | 0         | 13             | .000  | .000                      | 1.833                   |
| 12            | 980–<br>1020  | Early Pueblo<br>II         | 3,917                   | 5         | 20             | .250  | .222                      | 068                     |
| 13            | 1020–<br>1060 | Mid-Pueblo<br>II           | 4,028                   | 17        | 70             | .243  | .235                      | 008                     |
| 14            | 1060–<br>1100 | Late Pueblo<br>II          | 8,307                   | 24        | 45             | .533  | .539                      | 677                     |
| 15            | 1100–<br>1140 | Terminal<br>Pueblo II      | 11,641                  | 44        | 108            | .407  | .407                      | 779                     |
| 16            | 1140–<br>1180 | Early Pueblo<br>III        | 12,465                  | 30        | 35             | .857  | .889                      | 862                     |

Supplementary Table 2. Summary Data for Prevalence of Conflict in the Central Mesa Verde Region

through Time. For Complete Listing of Sites Used See Cole (2012:Table 13.3).

| 17                  | 1180–<br>1225 | Mid-Pueblo<br>III      | 13,958 | 4   | 34  | .118 | .092 | 913    |
|---------------------|---------------|------------------------|--------|-----|-----|------|------|--------|
| 18                  | 1225–<br>1260 | Late Pueblo<br>III     | 19,404 | 6   | 75  | .080 | .067 | -1.023 |
| 19                  | 1260–<br>1280 | Terminal<br>Pueblo III | 10,622 | 51  | 121 | .422 | .421 | 769    |
| total<br>or<br>mean |               |                        |        | 193 | 621 | .311 |      |        |

<sup>a</sup> From Varien et al. (2007:Table 4). Assumes six people/household.

<sup>b</sup> We used Bayes' theorem to generate an improved estimate of W from the observed sample proportion, as explained in Cole (2007). See also Robertson (1999) for discussion of this method.

<sup>c</sup> Standardized ratio of average potential maize production in each period from the high-frequency reconstruction, to average momentary population in each period.